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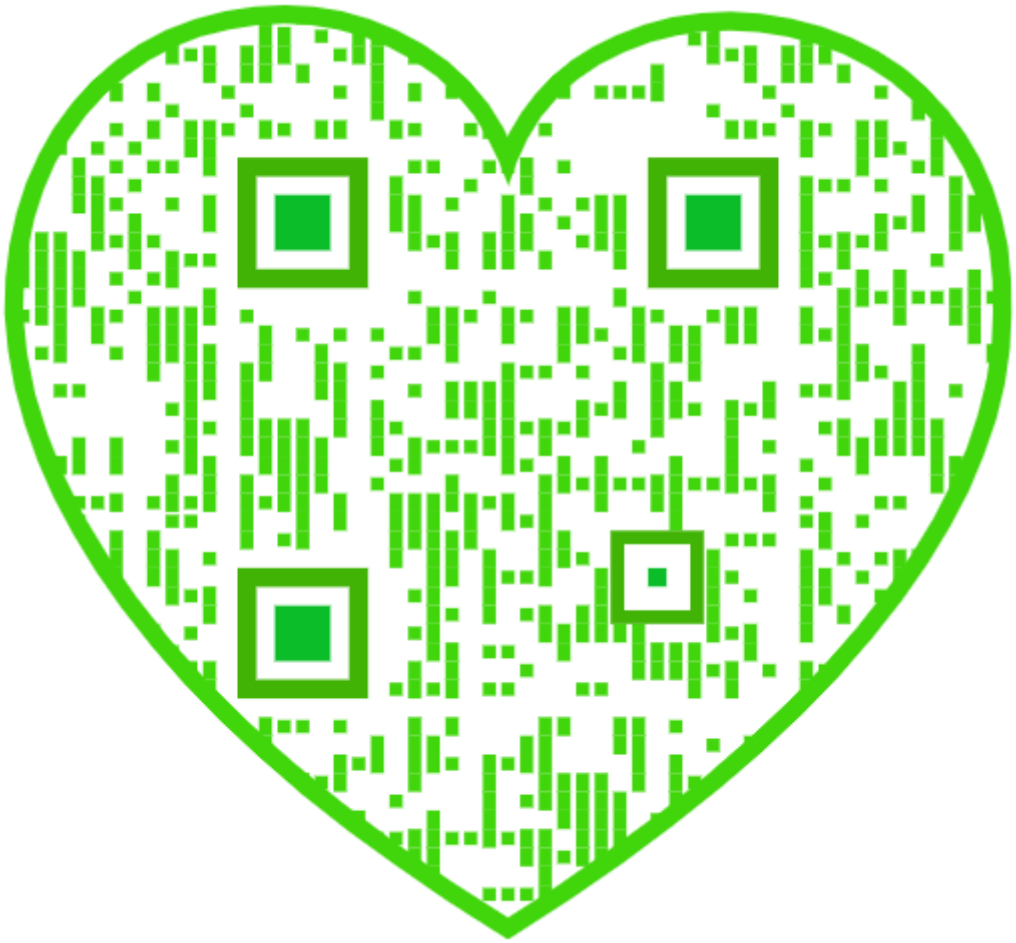

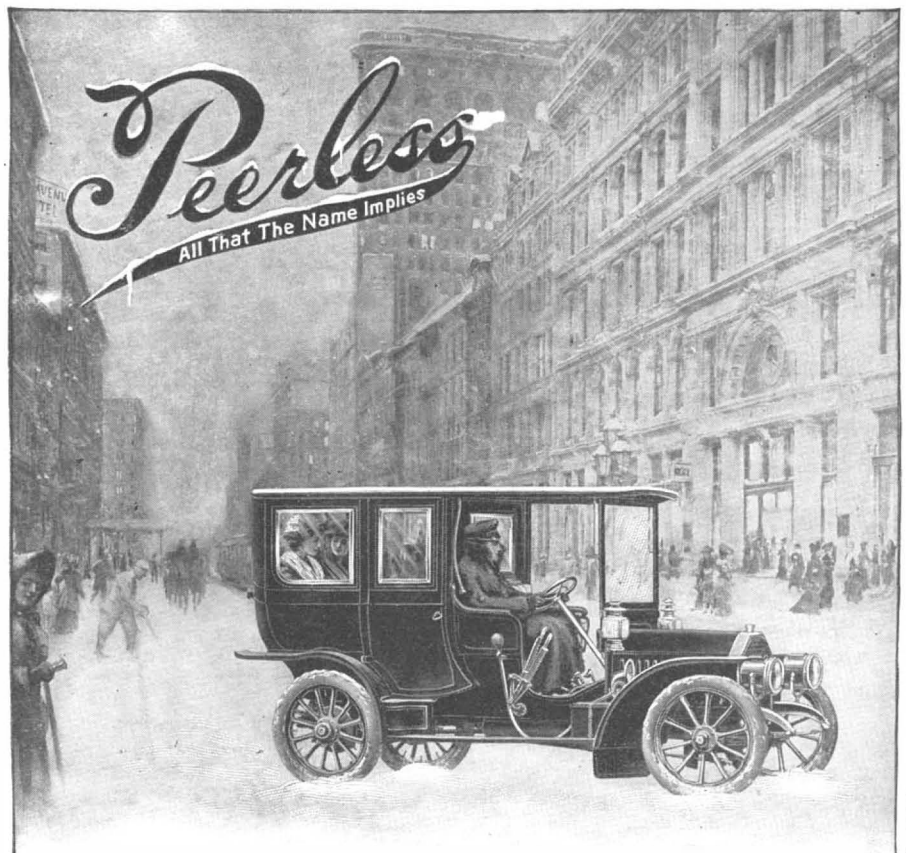

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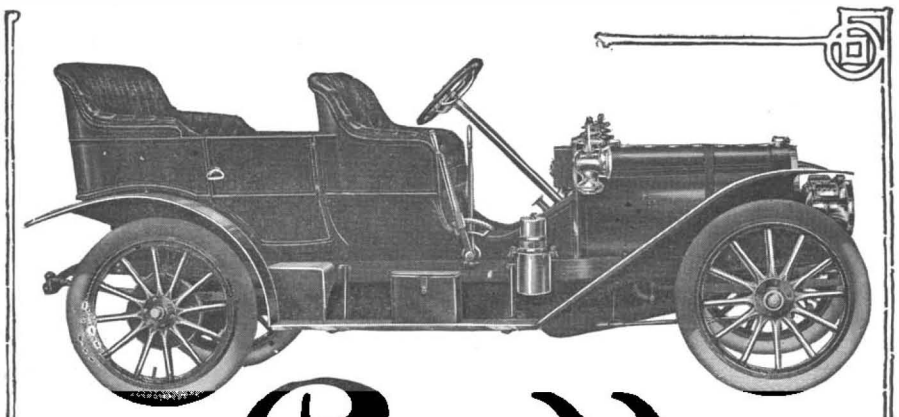

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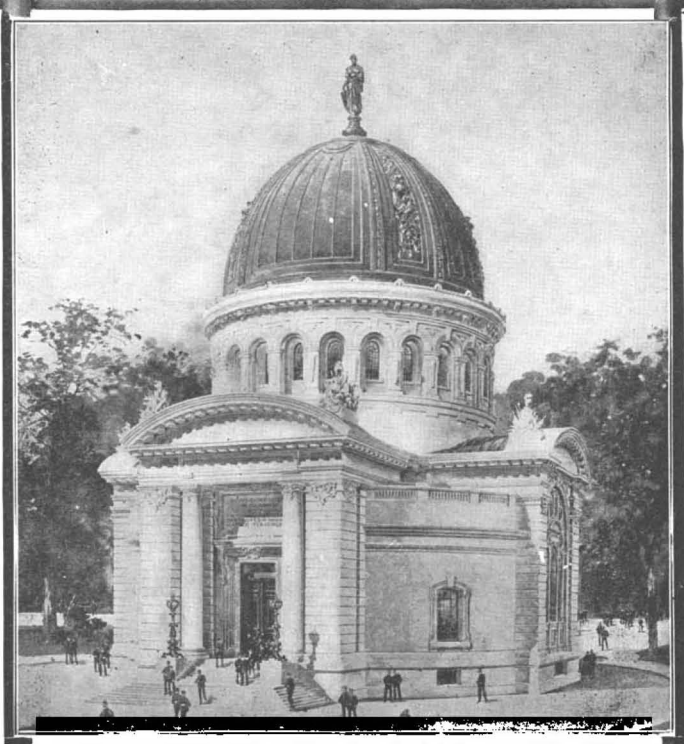

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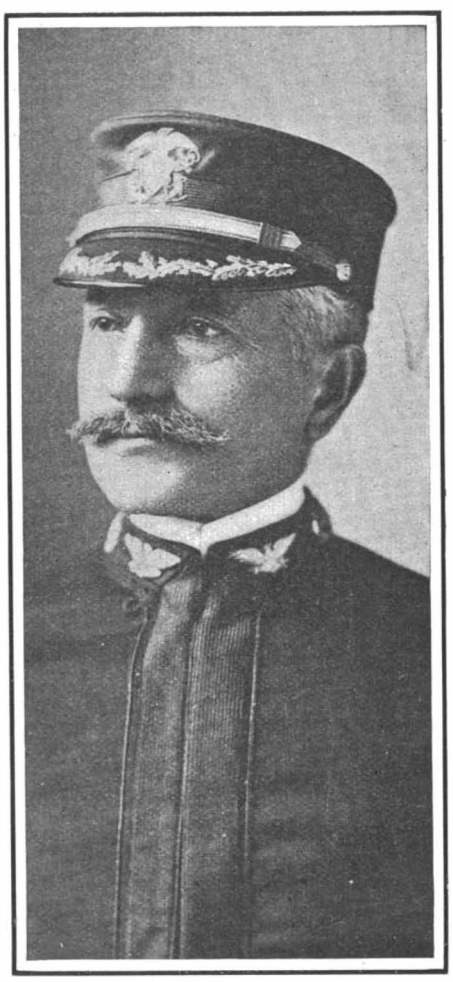

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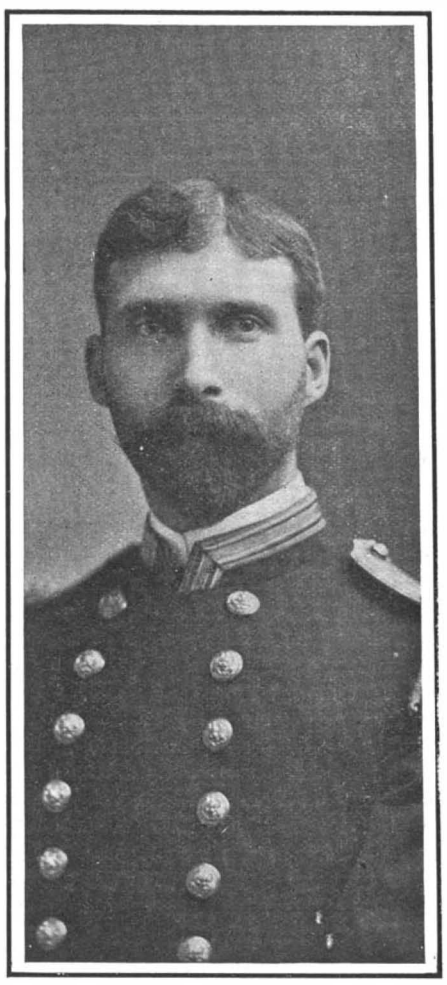

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NEW YORK, SATURDAY, DECEMBER 7, 1907.

The Editor is always glad to receive for examination illustrated articles on subjects of timely interest. If the photographs are *sharp*, the articles *short*, and the facts *authentic*, the contributions will receive special attention. Accepted articles will be paid for at regular space rates.

WHAT CONSTITUTES NAVAL STRENGTH?

It is a difficult matter to find a basis of comparison of the strength of the world's navies which will give satisfactory results. There are so many elements that affect naval efficiency, and the military value of these elements differs so widely, that it is simply impossible to make a comparison based upon any one of them, which will give a reliable result. A mere statement of the total number of ships in each navy will not suffice, since these ships vary in size, speed, armor, and armament. It has been claimed that a comparison based on the total number and weight of guns carried would suffice; but the value of a gun depends greatly upon the character of the ship which carries it, the kind of mount upon which it is placed, the degree of armor protection, and so forth. Because of these modifying conditions, a 12-inch gun in one ship may expect to have two or three times the battle-life and efficiency of a 12-inch gun in some other ship. Nor will a comparison on the basis of armor protection suffice; for a fleet which is powerful only in its defensive qualities, and in which the area and thickness of its armor plating has been increased at the expense of the armament and the speed, would be wanting in that mobility and power to swiftly concentrate and deliver a telling blow at the critical moment, upon which the success of a naval campaign so greatly depends. So also, a comparison on a basis of speed would be misleading; for high speed is one of the most costly elements in a warship, costly in the large demands which it makes upon displacement, and it is a fact that, unless the size of the units be very large, unusually high speed in warships is always associated with limited gun power and inadequate protection. A fleet of exceedingly fast, but moderately-armed and moderately-protected ships, might sweep the seas of the smaller unprotected cruisers and the general seaborne commerce of an enemy; but it would be powerless to force the issue by a decisive line-of-battle engagement. Then, lastly, and perhaps most important of all, there is the question of age. We do not recall any product of human industry which, as the years go by, depreciates so rapidly in value as the warship; and the most elaborate estimate of the relative value of the fleets of the world is not worth the paper it is written on, unless the question of the age of the ships be most carefully considered. Warships built to-day have at least twice the value of those built ten years ago, and from four to six times the value of those built twenty years ago. Great Britain awoke to this fact and acted upon it in the most trenchant way, when she swept over one hundred warships off the list, and placed them under the auctioneer's hammer.

For some years past the SCIENTIFIC AMERICAN has claimed that the only true basis of comparison of naval strength is one based upon total displacement, modified by considerations of age. Unless there be glaring faults in the design, a ton of displacement in one ship is worth about as much as one ton in another ship of the same class and date. The profession of naval architect is one of the most expert in the world, and it is represented by an exceedingly able body of men. Let three leading architects—English, French, and American—compete in the design of a battleship of given displacement, and though the ships may differ in details, the total fighting value will be about the same for all three. It must be admitted, however, that the enormous value given to the heavy, long-range, armor-piercing gun by the results of the Japanese war, has called for a modification in the above method of comparison. If the present popular theories are correct, the navy which can place on the shortest battle line the largest number of 12-inch, or other heavy pieces of modern design, is certain to win the fight; and an estimate of the strength of the navies on this basis will greatly modify the results obtained on a basis of displacement and age only. We give elsewhere the results of a comparison in which is included no gun that is not able to pierce heavy armor at 5,000 yards range, and which includes no piece in the respective guns below the 50-caliber 9.2-inch gun, the 45-caliber 10-inch, the 40-caliber modern 11-inch, the 35-caliber 12-inch, and the 35-caliber 13-inch and 13½-inch. This reservation excludes from the table all the battleships of the "Royal Sovereign" class of the British navy; the "Iowa," whose 12-inch gun has only about 2,000 foot-seconds velocity, in our navy; all the battleships of the "Wittelsbach" and "Kaiser Friedrich III." classes of the German navy, which carry an old model 9.4-inch gun, and those of the "Brandenburg" class, mounting an old model 11-inch. The result shows that England can place in the battle line 292 heavy armor-piercing guns; that France is second with 160 such guns; the United States third with 144 guns; and Japan and Germany are equal, each with 118 guns. This comparison takes in all the ships authorized, under construction, and already built. The large number of heavy guns carried in the Japanese navy in proportion to displacement shows how they are applying the lessons of their own war.

THE BATTLESHIP AND GUN OF THE FUTURE.

The running fight which followed the sortie of the Russian fleet at Port Arthur, and the decisive battle of Tsushima Straits, crystallized into fact many theories of the design and maneuvering of warships; and settled, probably for many years to come, the vexed questions of the size of ship, the type of gun, and the best formation in which to fight a naval action. The battleship of the future will be of great size; displacement will be not less than 20,000 tons; and this will increase so rapidly that a 30,000-ton ship will probably be afloat before the close of the next decade. The main armament will consist exclusively of heavy guns of not less than 12 inches caliber; and, unless the difficulty of erosion can be overcome, the 12-inch will give place to a 13-inch and, possibly, to a 14-inch piece. Future engagements will be fought at an extreme range, the extent of which will be limited only by the ability of the fire-control officer to see the fall of the shots. The determination of the range at which an engagement shall be fought will lie with the fleet which possesses the fastest speed.

It is to-day the almost unanimous opinion of naval officers that one big ship is more effective than two smaller ships of half her size. Future engagements will be fought with the two fleets steaming in parallel lines, in what is known as line ahead formation; that is, with each ship of a fleet steaming in the wake of the one ahead, with an interval of about 500 yards between them. If, of two such fleets, one were made up of four 20,000-ton battleships, each carrying eight 12-inch guns, the whole line would be about 2,100 yards in length; and if the other fleet consisted of eight 10,000-ton ships, each mounting four 12-inch guns, the line would be 5,600 yards in length, or over three miles. The fleet of larger ships would probably have sufficient advantage in speed for the admiral to maintain his four vessels abreast of the first four of the enemy's line; and, in this case, an eight-gun ship would be opposed to a four-gun ship, with the inevitable result (if the gunners were at all equally matched) that the four smaller ships would be silenced. The fleet of larger vessels would then slacken speed and drop back, taking the ships of the enemy in turn, and smothering them with a superior gun fire. At the opening of such an engagement the fifth and sixth in line of the four-gun ships would be able to direct a diagonal fire upon the last of the eight-gun ships, but the range would be so great that it could not prove to be very effectual. *Unquestionably, the victory in future engagements will lie with the fleet which is able to concentrate the largest number of heavy guns within the shortest line of battle.* Hence, the *raison d'etre* of the big ship; and, hence the certainty that the navies of the world have been forced into a contest of size, the end of which no one can foretell.

The enormously destructive power of the big gun at close ranges; the unwillingness of an admiral to expose his costly ships to the swift destruction which a close-range engagement would involve; and his natural desire to utilize the skill of his gunners to the utmost by forcing the supposedly less skillful enemy to fight at the greater ranges, are responsible for the fact that in the Japanese war the range was about 5,000 yards, and in future wars will probably be 7,000 and over. But at long ranges it is only the larger guns that can do effective work against an armored ship; and it has come to be pretty generally conceded that for this purpose the 12-inch piece is the most satisfactory. It is true that the 50-caliber, 9.2-inch gun, and long-caliber pieces of 10-inch and 11-inch caliber, are also armor-piercers at this range; but it takes the 12-inch gun to get through belt, barbette, and turret armor, and the destructive effect of the heavier projectiles is enormously greater. Furthermore, the flatter trajectory, or curve of flight, of the larger gun means a much wider danger space; that is to say, the 12-inch piece can hit a ship with a much wider margin of error in elevation than a 9.2-inch or 10-inch gun; and, although the smaller gun will deliver more projectiles, it is now generally conceded that the greater destructive effects and the greater certainty of hitting of the 12-inch overbalances the advantages of greater rapidity of fire of the lighter guns.

Now, although the above considerations will lead to the elimination from the main batteries of future battleships of mixed batteries of 6-inch, 7-inch, 8-inch, and 12-inch guns, such as are mounted on the "Georgia" and the "Connecticut," there is another and most important consideration which will lead to the mounting of only one caliber of gun on future ships, and that is the question of "fire control." The latest method of obtaining the range and of directing the fire is not dependent, as is popularly supposed, upon the range finder. Because of the narrow base line afforded by even the largest ships, it is impossible to estimate distances, at the great ranges which are now used, with any accuracy, by even the best form of range finder. The method now adopted is to have a "fire-control station" in some lofty position on the ship, and find the range by trial shots. The observing officer notes the splash of the shell and telephones the result to the gun, and the elevation is changed until a hit is made. Now, when three or four calibers of guns are firing indiscriminately, it becomes difficult to distinguish the splash of one caliber of shell from that of another. With one type of gun on the ship, there can be no error of this kind, and the fire can be directed with great accuracy.

As to the size of the future gun, there are indications that it will steadily increase. Already, Great Britain is, we understand, manufacturing a new and extremely powerful 13½-inch piece for her new twelve-gun ships. The advantage of size is not only that the bigger gun is more accurate, but that it holds its velocity longer, and its striking energy is therefore proportionately greater at the longer ranges. Increase in caliber, however, means a great increase in weight; and, were it not for erosion, our ordnance officers would prefer to obtain increased accuracy and striking energy by an increase of velocity. By using the wire-wound system and increasing the powder charge, it would be possible to produce a 12-inch gun which would be even more accurate than a 13½-inch of the ordinary model, and would strike a blow of equal energy. But the increased erosion in such a gun would render its life very short—a defect which might have disastrous consequences in a long-drawn-out naval campaign.

REMARKABLE TARGET PRACTICE BY THE FLAGSHIP OF THE PACIFIC FLEET.

If the results recently obtained in target practice by Admiral Evans's flagship, the "Connecticut," may be taken as representing the average skill of the gunners on the sixteen battleships of the Pacific fleet, the fighting value of the fleet is established beyond all question. Two targets, each measuring 30 feet high by 50 feet long, were used, the fire during the earlier part of the run being directed at the first target, and the later shots being aimed at the second target. The "Connecticut," steaming at 10 knots an hour, opened fire at four and a half miles. She continued firing for eight minutes; and, at the command to cease fire, she was five and a half miles from the second target. In that time she had put through the target four 12-inch, nine 8-inch, and seventeen 7-inch shells. Considering the great range and that the target was only one-eighth as long as a modern battleship, this was phenomenally good shooting.

THE MOTOR TORPEDO BOAT—A NEW TYPE.

The purchase by the British Admiralty of the motor-driven torpedo boat, built and successfully tested last winter by Messrs. Yarrow, must be regarded as an official indorsement of a new type of fighting craft. The vessel was built entirely on the responsibility of Messrs. Yarrow, and under the conviction that there would be a wide field of usefulness in store for it, as forming part of the naval defenses of estuaries and harbors. The original idea of the torpedo-boat flotillas was that they should consist of a large number of small and comparatively cheap units, each possessing high speed, and exposing only a small area to gun fire. In recent years, however, in the endeavor to secure higher speeds, there has been a steady departure from at least two of these essential principles. The boats have grown larger and more costly, until, from the original size of 75 feet, they have grown to an overall length of 150, with a proportionate increase in the cost. The builders of this craft believe that it will be possible, by making use of internal-combustion engines, to return to first principles in these two respects, without sacrificing too much of the present high speed.

The small size of these boats would enable them to form part of the boat equipment of battleships and cruisers. The earlier attempts to carry torpedo boats on warships failed, because the restrictions on size rendered it impossible to install steam engines of sufficient power.

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THE TRUE SIGNIFICANCE OF THE PACIFIC CRUISE.

BY CAPT. A. T. MAHAN.

The projected movement of an American fleet of sixteen battleships, with attendant smaller vessels, from the Atlantic to the Pacific coast of the United States is an event not only important, both from the professional and national point of view, but striking to the imagination. It carries in itself certan elements of grandeur. It is therefore not surprising that it should have attracted particular notice from the press; but the effect upon the imagination of several journals has been such as to approach the border line of insanity. A measure designed upon its face to reach a practical solution of one of the most urgent naval problems that can confront a nation having two seaboards, extremely remote the one from the other, has been persistently represented as a menace to a friendly power—Japan; and so effectively has this campaign of misrepresentation been carried on, so successfully has an obvious and perfectly sufficient reason for this cruise been ignored in favor of one less probable, and, so far as knowledge went, non-existent, that certain of the press of Japan, we are told, have echoed the cry.

Not only so, but European journals, notably some in Great Britain, among them certain which are incessant in their warnings against Germany, and conscious that the whole distribution of the British fleet has of late been modified, with the object of increasing the battleship force quickly available for the North Sea, where their only enemy is Germany, nevertheless affect to deprecate the dispatch of a United States fleet from its Atlantic to its Pacific coast, where it will be four thousand miles from Japan, against the two or three hundred which separate England and Germany. A new British naval base has been established on the North Sea. The naval maneuvers of this autumn, in which have taken part twenty-six battleships and fifteen to twenty armored cruisers, that is, over forty armored vessels, with other cruisers and torpedo boats in numbers, have been in the North Sea; one coast of which only is British as our Pacific coast is ours. The Naval Annual for this year, a publication conservative in tone as well as high in authority, discusses the strategy of the North Sea with unhesitating reference to Germany. I take from it the statement that by May, 1908, 86 per cent of the British battleship strength will be concentrated in or near home waters. Yet in the face of all this, the rulers of Great Britain and Germany, at this very moment of my writing, find no difficulty in exchanging peaceful assurances, the sincerity of which we have no good reason to doubt. Have we also forgotten that upon the Emperor William's famous telegram to Kruger, a British special squadron was ordered into commission, ready for instant movement? Whether a retort or a menace, even so overt a measure, in home waters, gave rise to no further known diplomatic action. We Americans are attributing to other peoples a thinness of skin, suggestive of an over-sensitiveness in ourselves which it was hoped we had outgrown.

Let it be said at once, definitely and definitively, that there is in international law, or in international comity, absolutely no ground of offense to any state, should another state, neighbor or remote, see fit to move its navy about its own coasts in such manner as it pleases. Whatever Germany may think of the new distribution of the British navy, she says nothing, but will silently govern her own measures accordingly. The statesmen of Japan, who understand perfectly the proprieties of international relations, know this well, and doubtless retain their composure; but the result of the action of certain of the American press has been to stir up popular feeling in both countries, by the imputation to the United States government of motives and purposes which cannot be known, and which *prima facie* are less probable than the object officially avowed. Whether this endeavor to rouse ill blood has been intentional or not, is of course known only to the editors; but grave ground for suspecting even so unworthy a motive as to injure the national administration is fairly to be inferred from such a paragraph as I shall here quote, from a New York journal of October 6. My chief object in quoting, however, is not to impugn motives, however reasonable such construction, but to emphasize the essential characteristic of the coming movement of our fleet:

> "Suppose that soon after the New Orleans riots, when relations between the United States and Italy were 'strained,' the American fleet had been sent on a practice cruise to the Mediterranean.
>
> "Suppose that soon after the Venezuela message, Mr. Cleveland had ordered the whole American fighting naval strength to take a practice cruise off Nova Scotia or Jamaica."

Such action, in either supposed case, would have been wantonly insolent and aggressive, calculated to provoke hostilities, and such as no statesman would take, unless he had already determined to force war, or saw it looming large on the horizon; as the British fleet was sent to Besika Bay in 1878. The insolence, aggression, and provocation, however, would have been the demonstration off the coast of the nation with whom diplomatic difficulty existed. Occurring when these innuendoes did, in the midst of the virulent campaign of imputation of warlike purposes against the Administration, the inference is irresistible that there was deliberate intention to parallel the sending of our fleet from our one coast to our other to a measure as offensive as those named. The distinguishing characteristic of the movement now projected, from the international point of view, is that it is not in the nature of a demonstration, peaceful or hostile, off the coast of any other state, much less off that of one with whom our relations are asserted by the press to be delicate. Not every man in the street, however, could detect the fallacy. It is a maxim of law that intention can only be inferred from action. So wild an insinuation, in the columns of a journal distinguished for intelligence, can, so far as the action shows, be attributed only to a willingness to mislead, or to a loss of head.

In pursuing the next aspect of this cruise to which I purpose to devote attention, I am led again to quote the same journal. The slip lies before me, but I have failed to note the date:

> "We are asked to believe that this expedition to the Pacific is a mere 'practice cruise.' He must be a miracle of innocent credulity who believes it. What observant men perceive in this dangerous situation is a cataclysm trained and bridled for Theodore Roosevelt to bestride and run amuck."

The last sentence is not necessary to my purpose; but I preserve it, partly for that gem of metaphor, "a cataclysm trained and bridled," and partly for the directness of the charge against the President of preparing conditions that must issue in war.

For the rest, if to believe in the obvious and adequate motive of practice for the fleet is to be a "miracle of innocent credulity," such I must admit myself to be; and I do so heartily. I am not in the councils of either the government or the Navy Department. I have neither talked with nor heard from any person who from official position could communicate to me any knowledge of the facts. My own information has been confined throughout to the newspapers. Shortly after the purpose to send the fleet became known, and counter agitation to be made, I had occasion to write to a British naval friend; and I said to him then that, while I had no clue to the motives of the Administration, it seemed to me that a perfectly sufficient reason was the experience to be gained by the fleet in making a long voyage, which otherwise might have to be made for the first time under the pressure of war, and the disadvantage of not having experienced at least once the huge administrative difficulties connected with so distant an expedition by a large body of vessels dependent upon their own resources. By "own resources" must be understood, not that which each vessel carries in herself, but self-dependence as distinguished from dependence on near navy yards—the great snare of peace times. The renewal of stores and coal on the voyage is a big problem, whether the supply vessels accompany the fleet or are directed to join from point to point. It is a problem of combination, and of subsistence; a distinctly military problem. To grapple with such a question is as really practical as is fleet tactics or target practice.

To this opinion I now adhere, after having viewed the matter in the light of such historical and professional thought and training as I can bring to it. Other reasons may have concurred; of this I know nothing. The one reason, practice, is sufficient. It is not only adequate, but imperative. The experiment—for such it is until it has become experience—should have been made sooner rather than be now postponed. That it was not sooner attempted has been, probably, because the growth of the navy has only now reached the numbers, sufficiently homogeneous, to make the movement exhaustively instructive.

The word *practice* covers legitimately many features of naval activity, which differ markedly and even radically from one another, though all conducive to the common end—proficiency. I may perhaps illustrate advantageously by a remark I have had occasion to make elsewhere, upon two theories concerning the summer practice cruises of the Naval Academy. There were—probably still are—those who advocated spending most of the allotted time in quiet, contracted, waters, following a prearranged routine of practical drills of various descriptions, which would thus be as little as possible disturbed by weather or similar impediment. Others favored the practice vessels putting out at once to sea for a voyage of length, amounting often to five or six thousand miles, in which must necessarily be experienced many kinds of weather and other incidents, reproducing the real life of the sea, and enforcing such practical action as the variable ocean continually exacts. It is evident that these conceptions, though opposite, are not contrary to each other, but complementary; and a moment's thought shows that under another phase they reappear in every fleet, if its active life is thoughtfully ordered with a view to full efficiency. It is imperative that a fleet, for a large proportion of the year, seek retired waters and relatively equable weather, for the purposes of drill with the guns; from the slow graduated instruction of the gunners, the deliberate firing at a stationary target, and from a ship either at rest or slowly moving, up through successive accretions of speed, of ship and of discharges, until the extreme test is reached of fast steaming, and firing with the utmost quickness with which the guns can be handled. In like manner the maneuvering of a body of several ships in rapid movement, changing from one formation to another, for the ultimate purposes of battle, must progress gradually, in order that commanding officers and their under-studies may gain, not only ability, but confidence, based upon habit; upon knowledge of what their own ships can do, and what they may expect from the other vessels about them. Ships in battle order must keep at distances which, relatively to the speed maintained, are short; dangerously short, except where compensated by the sureness of handling based on long practice. It is clear also that alterations in the personnel of a fleet, which are of frequent occurrence, make constant tactical drills additionally necessary.

But when all this—and more not here specified—has been accomplished, whether at the Naval Academy or for the fleet, what has been done but lay the necessary foundation upon which to rear the superstructure of the real life of the profession? There remains still to fulfill the object—very different from mere practice, though dependent upon it—which alone justifies the existence of a navy. The pupil of the Naval Academy passes naturally and imperceptibly into the routine life of the service by the simple incident of being ordered to a sea-going ship; the single ship, the cruiser, gains her sufficient experience by the mere fact of staying at sea; but a fleet tied to its home ports, or to the drill ground, does not undergo, and therefore does not possess, the fullness of fleet life. Not only are the interruptions numerous and injurious; not only does the easily reached navy yard sap the habit of self-reliance; but out in the deep, dependent upon itself alone and for a long period, there await a fleet on a distant voyage problems so different in degree from those of a vessel alone as practically to be different in kind. Multiply any kind of difficulty by sixteen, and you have passed from one order of administration to another.

The movement of the United States battle fleet from the Atlantic to the Pacific coast is in the highest sense practical, because it is precisely the kind of movement which the fleet of any nation may, and usually will, be required to make in war. It is further practical, because the United States has a Pacific as well as an Atlantic coast, and has not a navy large enough to be divided safely between them. The question is at least debatable, whether for the near future the Pacific is not the greater center of world interest; as it certainly is, with regard to our own military necessities, one of greater exposure than the Atlantic. Like France, with her Mediterranean and Atlantic shores, the United States is in the painful military dilemma of being liable to attack upon one side while the fleet is on the other; but our distance to be covered is so much greater than that of France, that the position is vastly more embarrassing. A fleet of battleships leaving Toulon, full coaled and victualed, may reach Brest or Cherbourg without renewing the fuel and stores in its holds; but a fleet leaving New York or Norfolk for San Francisco has upon its hands a most serious administrative problem, and one which no accuracy of gun-fire, no skill in tactics, can meet. It is in fact the problem of Rodjestvensky, to use an illustration particularly apt, because recent. Can our navy in such case expect from the weak states of South America the facility for recoaling, etc., which was liberally extended to the Russian admiral, to the somewhat amazement of the naval profession, and to the just indignation of Japan?

It is an old saying that an army, like a snake, moves on its belly. This is little less true of a navy. In the foremost naval man of modern times, in Nelson, we, according to our several prepossessions, see the great strategist, or the great tactician, or the great fighting man; but the careful student of his letters realizes that, underlying all, is the great administrator, who never lost sight or forethought for the belly on which his fleet moved. The unremitting solicitude for the food essential to the health of his crews; the perpetual alertness to seize opportunity, indicated by such casual note, at sea: "Finished discharging storeship No. ——;" the slipping into Tetuan to fill with water, because little progress toward Gibraltar could be made against the current and temporary head wind; the strong self-control, holding down his constitutional impetuosity to move, till sure that all has been done to make movement far reaching, as well as accurate in direction; the whole culminating at the end of his life in a wide sweeping movement across the Atlantic, back to Gibraltar, and thence to Brest, a period of three months—about equivalent to that required for our projected transfer—during which he was never embarrassed about stores because always forehanded; that is the way—speed, not haste—in which wars are won. It was, and was recognized at the time to be, a magnificent instance of the mobility which is the great characteristic of navies as fighting bodies; not the mobility which consists in getting an extra half-knot

(*Continued on page 412.*)

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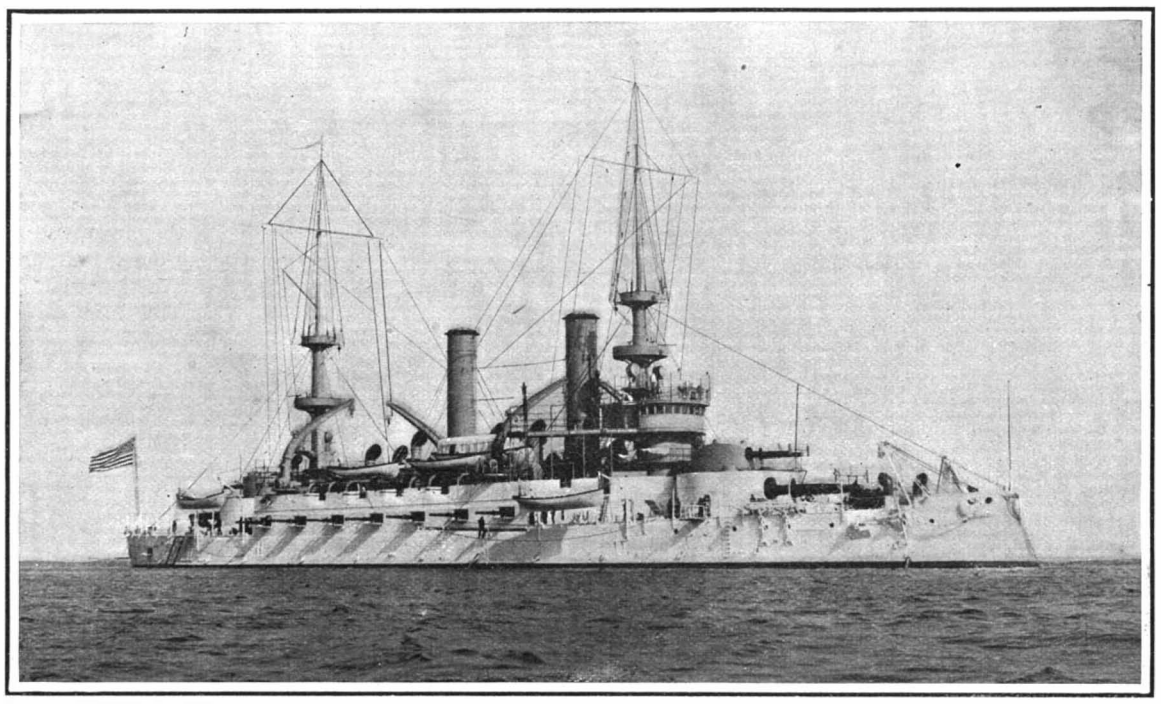
BATTLESHIPS

TEN YEARS' DEVELOPMENT OF THE BATTLESHIP FROM THE "KEARSARGE" TO THE "DELAWARE."

At the close of the Spanish war the United States navy included but four first-class battleships; and these have been so far outbuilt that to-day they are relegated to the class of coast defense vessels. These were the "Oregon," "Indiana," "Massachusetts," and "Idaho." The first battleships to go into commission after the close of the war were the "Kearsarge" and "Kentucky," built at Newport News. They marked a radical departure from their predecessors.



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Displacement, 11,540 tons. **Speed,** 16.9 knots. **Bunker Capacity,** 1,591 tons. **Armor:** Belt, 16½ inches to 4 inches; turrets, 15 inches to 17 inches; barbettes, 15 inches; deck: flat, 2¾ inches, slopes, 3 inches to 5 inches. **Batteries:** Four 13-inch B. L.; four 8-inch B. L.; fourteen 5-inch R. F.; twenty 6-pounders; eight 1-pounders; four Colts; two 3-inch field guns. **Torpedo Tubes,** 4. **Complement,** 589.

FIRST-CLASS BATTLESHIP "KENTUCKY." SISTER SHIP "KEARSARGE."

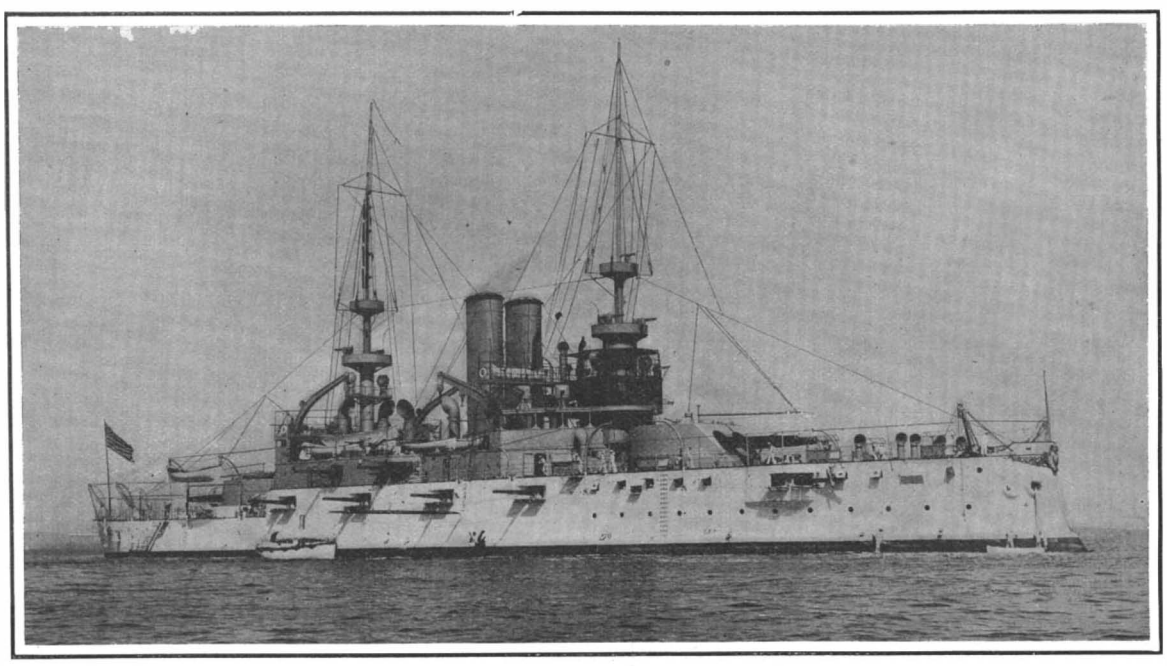
THE BATTLESHIPS "KEARSARGE" AND "KENTUCKY."

The distinguishing feature of the "Kentucky" was the method adopted of carrying the 13-inch and 8-inch guns of the main battery. With a view to obtaining as wide an arc of fire as possible, these guns were mounted in superposed or double-deck turrets, as to the merits of which there arose a very wide diversity of opinion among naval men. The 13-inch guns are mounted in the lower turret, upon the roof of which is carried a smaller turret for the 8-inch guns. The two turrets being constructed integrally, one turning mechanism serves for both pairs of guns; but each pair is, of course, provided with its own elevating gear. The obvious advantage of this mounting is that the 8-inch are never masked by the 13-inch guns, or by the superstructure, as is the case in the "Oregon," and all four of them are, therefore, available not only for end-on fire, but for fire on either broadside. The disadvantages are that a single successful hit by the enemy would probably put all the four guns of the turret out of commission at once. Another and perhaps more serious drawback is that four of the heaviest guns have to wait upon one another, and the rapidity of fire is, therefore, diminished. The ideal mounting for rapidity and general efficiency of fire is to carry each gun in a turret by itself. It can then be fired as often and whenever the officer in command desires, and without any reference to the fire of any other gun. Another element of danger is the open communications from the guns to the magazines, a fault for which, both in these and later ships, we were to pay dearly. Also the central battery of fourteen 5-inch guns is exposed to destruction by a single large shell. The "Kentucky" is a small battleship as size goes nowadays, with a displacement of 11,540 tons, a trial speed of 16.9 knots, and a bunker capacity of 1,591 tons. At the waterline she is protected by a belt 16½ inches thick amidships, tapering to 4 inches at the bow; the belt is not continuous, but terminates in the wake of the after main barbette, the protection of the after portion of the ship being left to the protective deck, which here is from 3 to 5 inches in thickness, being elsewhere in the flat portions of it 2¾ inches in thickness. Above the belt the side of the ship for about two-thirds of its length amidships is protected by a wall of 5-inch armor which extends to the main deck. Above this is a casemate battery protected by a wall of 6-inch armor, within which is mounted a battery of fourteen 5-inch guns, seven on a side. Also the ship carries twenty 6-pounders, eight of them on the gun deck, and twelve of them on the superstructure deck. All of the guns are served by electric hoists, and the big guns are also handled electrically. These ships are powerfully armed for their size; but, judged by modern ideas, their freeboard is low, being only about 13 feet, and the secondary battery, according to the ideas of the days in which they were built, was too light. But, curious to relate, the reversal of ideas as to the armament of ships has been such that, in respect of her secondary battery, the "Kearsarge" is thoroughly up-to-date, carrying a main armament of heavy guns, and a secondary armament of 5-inch guns for repelling torpedo attack. An improved type of this gun is to be mounted on our latest 20,000-ton ships of the "Delaware" class.

THE FIRST-CLASS BATTLESHIP "ALABAMA"—CLASS OF THREE SHIPS.

The next addition of battleships to our navy consisted of the three vessels of the "Alabama" class, namely, the "Alabama," "Wisconsin," and "Illinois." These vessels were built respectively at the Cramps' shipyard, at the Union Iron Works, San Francisco, and at Newport News. In one respect they hark back to the "Iowa," for, like her, they have a good freeboard, being provided with a forecastle deck with a height of about 20 feet above the water-line, this freeboard being continued to the aftermost main turret, where it is reduced by the height of one deck to a freeboard of about 13 feet. The displacement is about the same as that of the "Kearsarge" class, and with 11,207 horse-power they developed on trial about 17 knots. The armor plan is similar to that of the "Kearsarge," consisting of a waterline belt extending from the after main turret to the bow, 16½ inches thick amidships, 4 inches at the bow. Above this is a wall of armor, extending to the upper deck amidships, which is 5½ inches in thickness, and on the main deck this armor is pierced to carry eight 6-inch guns in casemates. Two 6-inch guns are mounted in casemates in the bow, and on the upper deck in casemates are carried four other 6-inch guns, two on each broadside. The main battery consists of four 13-inch guns, carried in turrets of 14-inch armor, above barbettes of 15-inch armor.

In the armament of these ships the government made a rather surprising departure from the previous battleships of our navy, by discarding the 8-inch gun altogether. In the six battleships which preceded them the 8-inch gun was, perhaps, the most striking characteristic of the armament, serving to distinguish our battleships from those of other navies, in which



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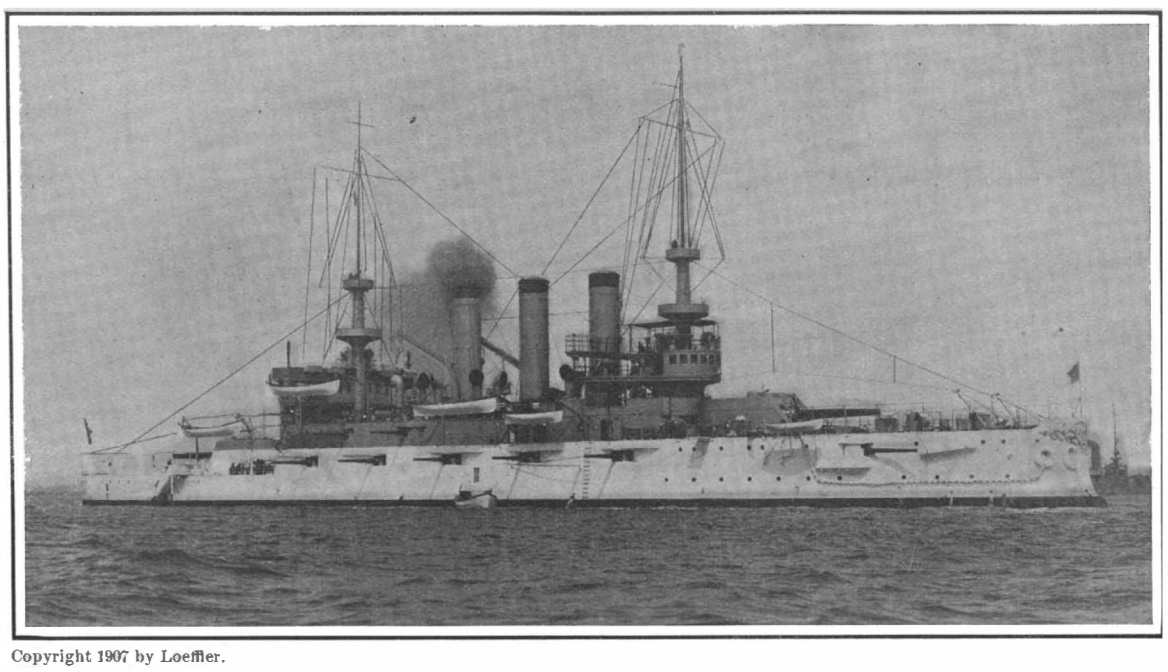
Displacement, 11,552 tons. **Speed,** 17.2 knots. **Bunker Capacity,** 1,310 tons. **Armor:** Belt, 16½ inches to 4 inches; turrets, 14 inches; barbettes, 15 inches; deck: flat, 2¾ inches, slopes, 3 inches to 4 inches. **Batteries:** Four 13-inch B. L.: fourteen 6-inch R. F.; sixteen 6-pounders; six 1-pounders; four Colts; two 3-inch field guns. **Torpedo Tubes,** 4. **Complement,** 590.

FIRST-CLASS BATTLESHIP "ALABAMA." ALSO "WISCONSIN" AND "ILLINOIS."



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Displacement, 12,500 tons. **Speed,** 18 knots. **Bunker Capacity,** 2,000 tons. **Armor** (Krupp): Belt, 11 inches to 4 inches; turrets, 12 inches to 11 inches; barbettes, 12 inches; deck: flat, 2¾ inches, slopes, 3 inches to 4 inches. **Armament:** Four 12-inch 40-caliber, sixteen 6-inch 50-caliber R. F.; six 3-inch R. F.; eight 6-pounders; six 1-pounders; two Colts; two 3-inch field guns. **Torpedo Tubes,** 2 submerged. **Complement,** 551.

FIRST-CLASS BATTLESHIP "OHIO." ALSO "MAINE" AND "MISSOURI."

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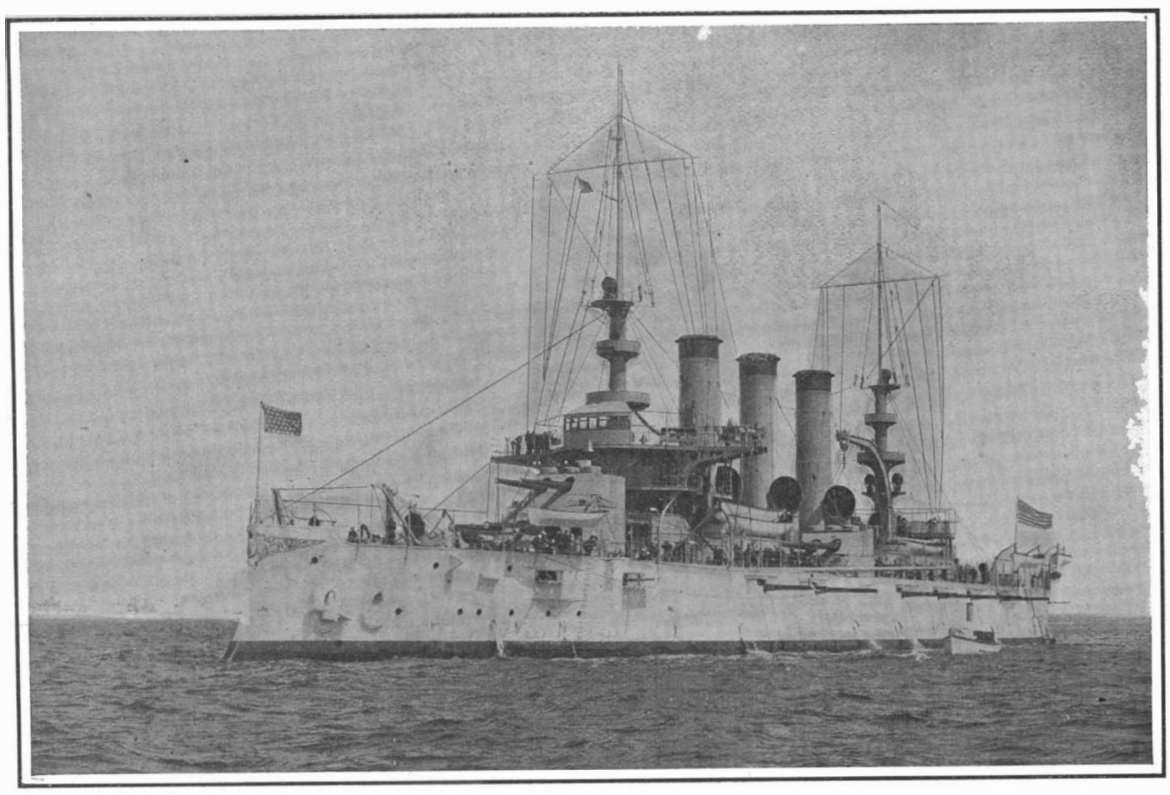
the usual plan was to carry four main 12-inch or 13-inch guns, and a secondary battery of 6-inch guns. But the United States battleships, in addition to the main and secondary batteries, mounted a powerful intermediate battery of 8-inch pieces. The disappearance of the 8-inch gun was greatly regretted by a majority of the officers of our navy, and its reappearance, later, in the "Georgia" class was hailed with profound satisfaction. The "Alabama" class, also, are readily distinguished from other battleships of the navy, by the fact that the boilers are placed fore and aft, and the two elliptical smokestacks are placed side by side, an arrangement which had been followed in the battleships of the "Royal Sovereign" class of the British navy.

FIRST-CLASS BATTLESHIP "MAINE"—CLASS OF THREE SHIPS.

On May 4, 1898, Congress authorized the construction of three battleships, the plans of which very closely followed those of the "Alabama" class, the idea being to have a homogeneous squadron of six identical vessels. When it was learned, however, that the contract speed of these ships was to be only 16 knots, which was about two knots slower than the speed of many foreign battleships, which were under construction at that date, there was a strong agitation in favor of the modification of these ships, which led to a revision of the plans to the extent of lengthening them by 20 feet, in order to provide the necessary space for an increase in the motive power. The "Alabama" class are 368 feet between perpendiculars, and the "Maine" class 388 feet, the other dimensions of the hull being identical throughout. The additional 20 feet of length raised the displacement from 11,552 tons in the "Alabama" to 12,500 tons in the "Maine"; and enabled the horse-power to be increased from about 11,000 to 15,603, with the result that on trial the "Maine" accomplished 18 knots. The "Maine" was built at Cramps, the "Missouri" at Newport News, and the "Ohio" at San Francisco. The additional length made it possible to mount an extra pair of 6-inch guns in the central battery, and the 35-caliber 13-inch gun of 2,100 foot-seconds velocity, gave place to the new 40-caliber 12-inch piece of 2,700 foot-seconds velocity. This resulted in a saving of 40 tons in the weight of the four guns, and a gain in penetration of from 12.5 inches at 3,000 yards for the 13-inch to 16.3 inches at the same distance for the 12-inch piece. An additional smokestack was added, and a return was made to the practice of placing the stacks on the longitudinal center line of the vessel. The previous battleships had all been protected with Harveyized armor; but in the "Maine" class, for the first time, the Krupp armor was employed, and it has been used in all subsequent battleships. Because of its higher resisting qualities, it was possible to reduce the thickness of the armor all round, the belt being 11 inches and the turrets 12 inches in thickness as against 16½ inches and 14 inches respectively in the "Alabama" class. The 6-inch guns also are of the latest 50-caliber pattern; and, taken altogether, these three vessels are to be considered the most heavily armed battleships of their particular type and date to be found in any navy. The bow 12-inch guns are carried at a height of 26½ feet above the water, the after 12-inch at a height of 19 feet. All four 12-inch can be loaded in any position, and both the hoisting of the ammunition and the maneuvering of the guns are done electrically.

FIRST-CLASS BATTLESHIP "GEORGIA"—CLASS OF FIVE SHIPS.

The Congress of 1899 authorized the construction of three, and the Congress of 1900 of two first-class battleships, which to-day constitute what is known as the "Georgia" class. These ships are the "Georgia," "Nebraska," "New Jersey," "Virginia," and "Rhode Island." The contract for the "New Jersey" and "Rhode Island" went to the Fore River Shipbuilding Company; for the "Georgia," to the Bath Iron Works; for the "Virginia," to the Newport News Company; and for the "Nebraska," to the Moran Brothers, at Seattle. These ships represent a great advance in size, speed, and power over the "Maine" class. The main battery consists of four 12-inch guns, and the secondary battery of twelve 6-inch pieces; but the 8-inch gun makes its reappearance once more, eight of these pieces being carried. The length is increased to 450 feet, and the beam to 76 feet 10 inches. The displacement is increased from 12,500 in the "Maine" to nearly 15,000 in the "Georgia," and the speed is 19 knots. The armor plan is generally similar to that of the "Maine," except that the belt is carried continuously from bow to stern. In order to secure a maximum concentration of fire the double turret was reintroduced, four of the 8-inch guns being carried on the roof of the 12-inch turret, the other four 8-inch being mounted in two turrets, one on either beam. The command of the large guns is exceptionally good, the 12-inch being 26½ feet above the water, and the center line 8-inch 32 feet above the water; the side 8-inch, 26 feet above the water; but the 6-inch guns of the secondary battery are only 12 feet above the waterline. The great defect of these ships is the lack of protection to the magazines below the big gun turrets. There are no handsomer battleships in our navy than these of the "Georgia" class. All of them made their contract speed of 19 knots, and, in several cases, this speed was considerably exceeded. They have a bunker capacity of 1,700 tons of coal, and, compared with other ships of their displacement and date, they carry an exceptionally heavy battery. When in the end-on position they can concentrate ahead or astern two 12-inch, six 8-inch, and two 6-inch. On either broadside they can train four 12-inch, six 8-inch, and six 6-inch guns. The guns of the superposed turrets, both 8-inch and 12-inch, can be trained through an arc of 270 degrees. The 8-inch guns on the beam have an arc of training of 180 degrees, and the guns of the 6-inch battery have an arc of training of 110 degrees. In these ships was mounted, for the first time, the new powerful turbine-driven 21-inch torpedo, for the firing of which each ship carries four submerged torpedo tubes.



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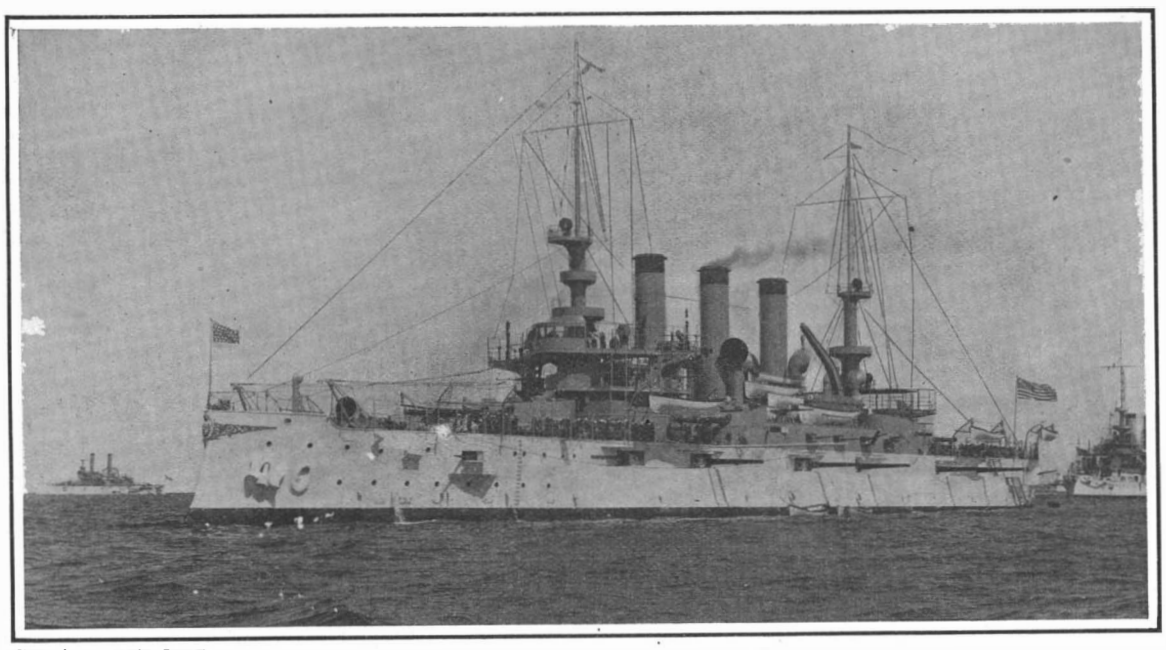
Displacement, 14,948 tons. **Speed,** 19 knots. **Bunker Capacity,** 1,700 tons. **Armor:** Belt, 11 inches to 4 inches; turrets, 11 to 10 inches and 6½ to 6 inches; barbettes, 10 inches and 6 inches; deck: flat, 1½ inch, slope, 3 inches. **Armament:** Four 12-inch 40-caliber B. L.; eight 8-inch 45-caliber B. L.; twelve 6-inch 50-caliber R. F.; twelve 3-inch R. F.; twelve 3-pounders; eight 1-pounders; two 3-inch field guns; six automatic guns; two machine guns. **Torpedo Tubes,** 4 submerged. **Complement,** 705.

FIRST-CLASS BATTLESHIP "VIRGINIA."



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Displacement, 16,000 tons. **Speed,** 18 knots. **Coal Supply,** 2,200 tons. **Armor:** Belt, 11 inches to 4 inches; casemates, 7 inches; main turrets, 12 inches; secondary turrets, 8 inches; deck, 3 inches. **Armament:** Four 12-inch, eight 8-inch, twelve 7-inch, twelve 3-inch rapid-fire guns, 26 smaller guns. **Torpedo Tubes,** 4 submerged. **Complement,** 803.

BATTLESHIP "LOUISIANA." ALSO "CONNECTICUT."

FIRST-CLASS BATTLESHIP "CONNECTICUT"—CLASS OF SIX SHIPS

Following the "Georgia" class came the authorization in 1902 of the "Connecticut" and "Louisiana," and in the following two years of the "Kansas," "Minnesota," "Vermont," and "New Hampshire." In the same year also were authorized two battleships, the "Idaho" and "Mississippi," of less size, power, and speed, of which we shall speak later. The first six vessels form, like the ships of the "Georgia" class, a homogeneous squadron. The "Connecticut," built at the Brooklyn navy yard, and the "Louisiana," built at Newport News, are practically identical. The "Kansas" and "New Hampshire," built by the New York Shipbuilding Company; the "Minnesota," built at Newport News; and the "Vermont," built by the Fore River Shipbuilding Company, differ slightly in armor and other details from the two earlier ships. In the "Connecticut," as compared with the "Georgia," the length was increased by 15 feet, the beam by 7½ inches, and the draft by 9 inches, the displacement being raised from 14,948 tons to 16,000 tons. The armor plan remained practically the same, except that the protection to the lower deck and casemates was increased to 7 inches. The battery, however, is greatly increased in power, the latest pattern of 45-caliber 12-inch gun being mounted in these ships for the first time in our navy. In addition to four of these carried axially in barbette turrets forward and aft, there are eight 45-caliber 8-inch guns in turrets on the broadside, and an exceedingly powerful secondary battery mounted in casemates on the gun deck, consisting of twelve 7-inch 50-caliber rapid-fire guns. The 7-inch gun is a new gun, and it was mounted for the first time in the "Connecticut" and "Louisiana." It is a 50-caliber piece, capable of penetrating 6.4 inches of Krupp armor at 3,000 yards. The fire in any direction from these ships is heavy, consisting of two 12's, four 8's, and two 7's ahead and astern, and four 12's, four 8's, and six 7's on the broadside. They are provided with four submerged torpedo tubes for the new turbine torpedo, and they have the large coal supply of 2,200 tons. Both the "Connecticut" and "Louisiana" exceeded their high contract speed of 18 knots with

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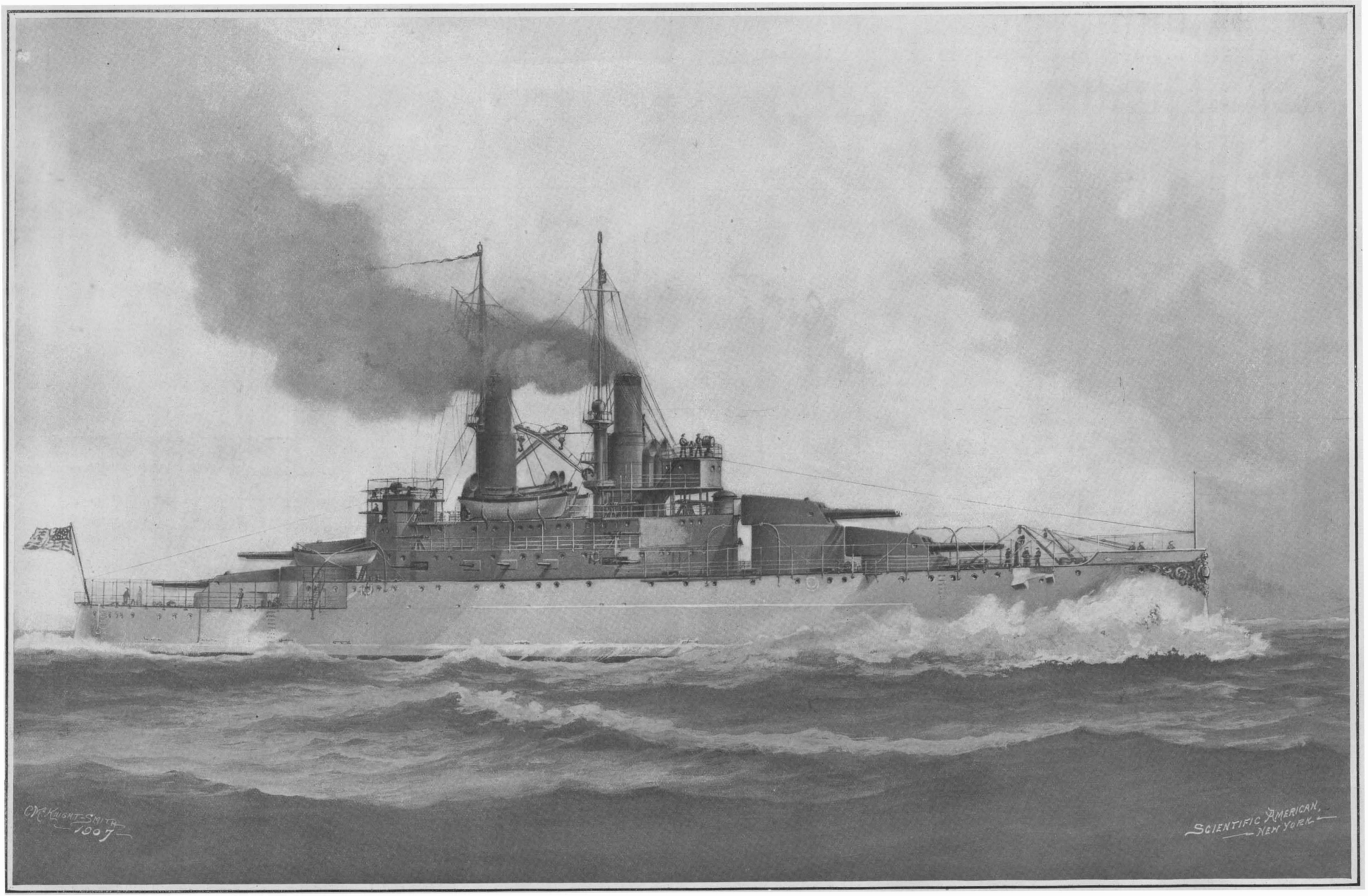

Displacement, 16,000 tons. **Speed,** 18.5 knots. **Coal Supply,** 2,200 tons. **Armor:** Belt, 12 inches; casemate side armor, 10 to 8 inches; barbettes and turrets, 10 to 12 inches. **Armament:** Eight 45-caliber 12-inch guns; twenty-two 3-inch guns. **Torpedo Tubes,** 2 submerged, 21-inch.

FIRST-CLASS BATTLESHIP "SOUTH CAROLINA." ALSO "MICHIGAN."

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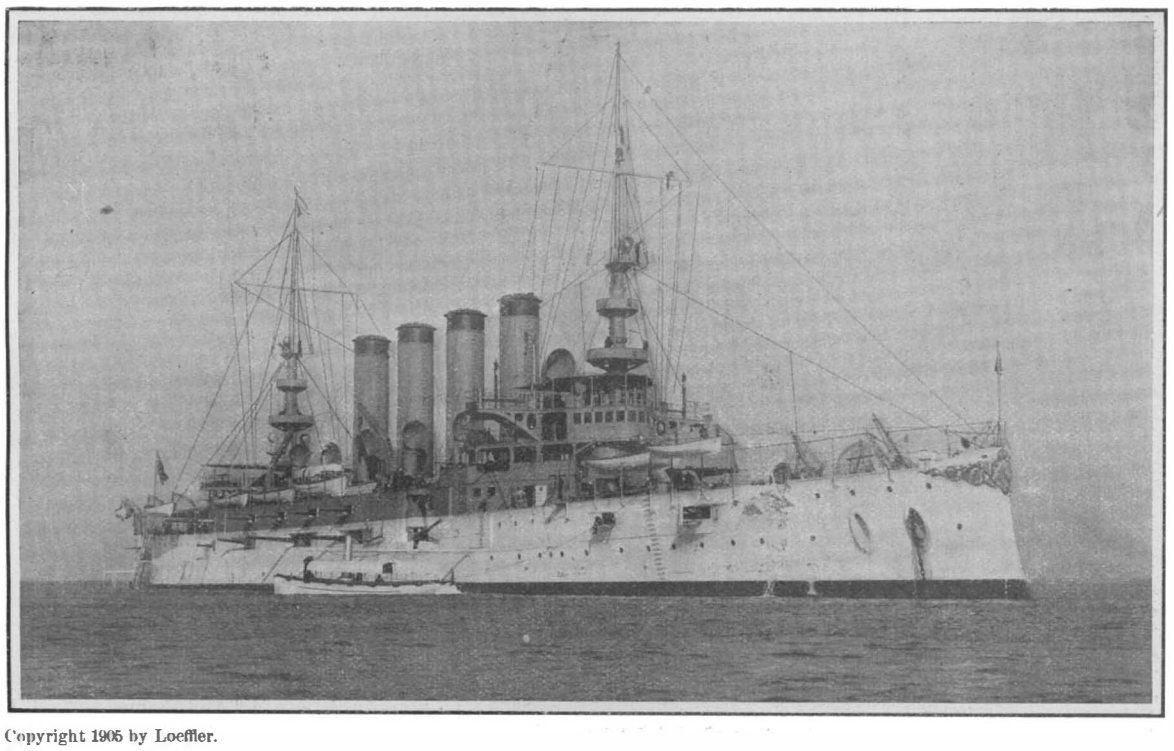
CRUISERS

ARMORED CRUISERS OF THE "CALIFORNIA" AND "WASHINGTON" CLASSES—TEN SHIPS.

During the Spanish war, the armored cruiser gave such clear demonstration of its value, that it was not long before Congress had authorized the construction of a powerful class of five of these ships, to embody the latest ideas for this type. The class includes the "California" and "South Dakota," built at San Francisco; the "Colorado" and "Pennsylvania," built by Cramps; and the "Maryland" and "West Virginia," built by the Newport News Shipbuilding Company. These ships are 502 feet long, 69 feet 6½ inches beam, and 24 feet 1 inch draft, on which draft they displace 13,680 tons. In outward appearance they are exceedingly handsome ships, with two masts and four funnels. Their freeboard varies from 20 feet at the bow and stern to about 19 feet amidships. The protection consists of a continuous belt from 6 to 3½ inches in thickness, associated with a deck having a thickness of 4 inches on the slopes, and 1½ inches on the flat. Above the main belt, the side of the ship amidships, for about one-third of the ship's length, is protected by 5 inches of armor with 4 inches transverse bulkheads. The main battery of four 8-inch guns is carried in two turrets forward and aft, and the fourteen 6-inch guns are mounted in a central broadside battery and in casemates, ten of the guns on the gun deck and four on the main deck. There is also a battery of eighteen 14-pounders mounted on the gun deck and in the superstructure. The ships were designed to make 22 knots with 22,000 horse-power, but this was in every case exceeded, the "Pennsylvania" making about 22½ knots, and the other vessels from 0.13 to 0.24 knot in excess of the contract speed. The ships carry a maximum supply of 2,000 tons of coal, and each is fitted with two 18-inch submerged torpedo tubes. Subsequently, four cruisers were authorized, which are nearly 1,000 tons larger than the "California" class, and embody improvements in the armament and armor plan. These are the "Washington," built by the New York Shipbuilding Company; the "Tennessee," built at Cramps; and the "Montana" and "North Carolina," now building at Newport News. The improvements consist of lengthening the belt until it extends well beyond the barbettes of the main guns; substituting four 10-inch 40-caliber guns, in place of the four 8-inch 45-caliber guns, and adding a pair of 6-inch guns to the secondary battery, making sixteen in all.

Although the ships of this class are the equal of those armored cruisers of foreign navies designed at the same date, they are entirely outclassed by the later armored cruisers of other navies, such as the Japanese "Tsukuba," with its four 12's, twelve 6's, and twelve 4.7's, and the British "Invincible" class, carrying eight 12's and sixteen 4-inch guns.



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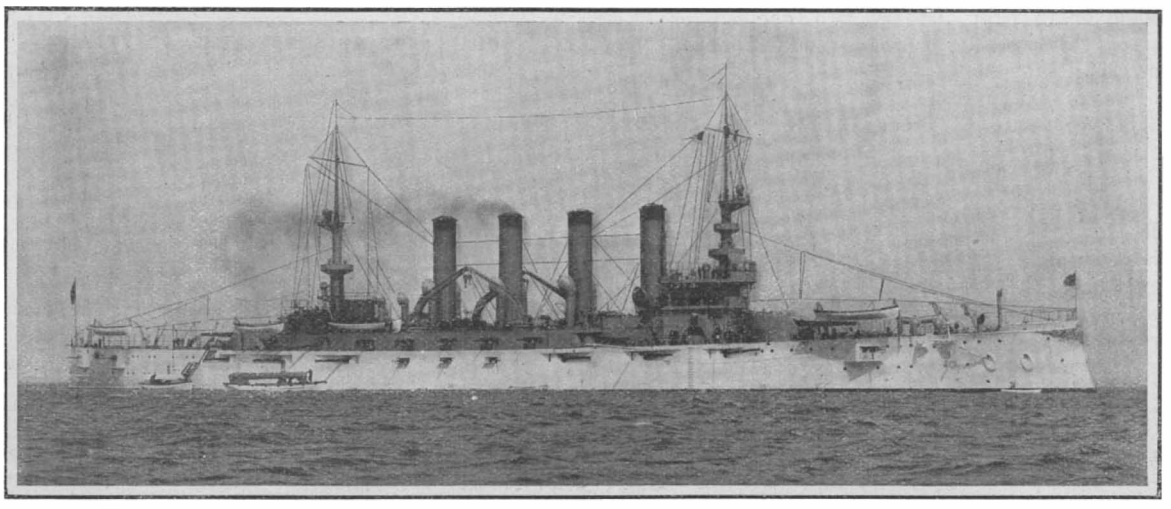
Displacement, 13,680 tons. **Speed,** 22 knots. **Bunker Capacity,** 2,000 tons. **Armor:** Belt, 6 inches to 3½ inches; turrets, 6½ inches to 6 inches; barbettes, 6 inches; deck, 1½ inch to 4 inches. **Armament:** Four 8-inch 45-caliber B. L.; fourteen 6-inch 50-caliber R. F.; eighteen 3-inch R. F.; twelve 3-pounders; eight 1-pounders; two 3-inch field guns; two machine guns; six automatic guns. **Torpedo Tubes,** 2. **Complement,** 822.

ARMORED CRUISER "PENNSYLVANIA." ALSO "CALIFORNIA," "SOUTH DAKOTA," "COLORADO," "MARYLAND," AND "WEST VIRGINIA."



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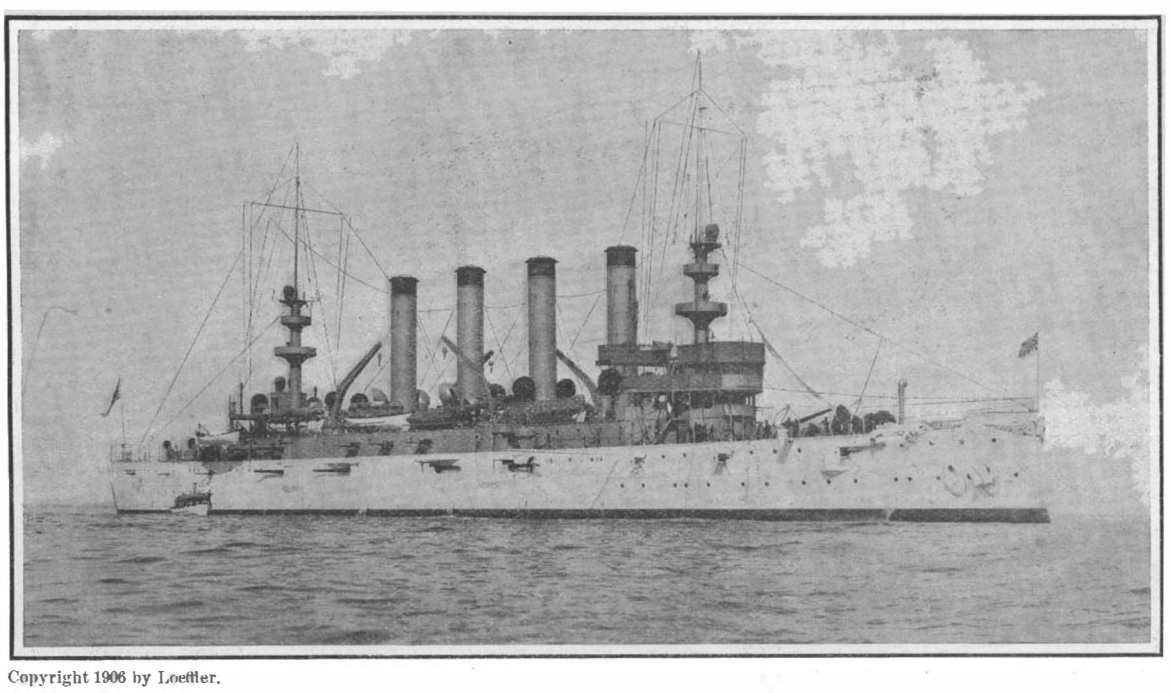
Displacement, 14,500 tons. **Speed,** 22 knots. **Bunker Capacity,** 1,950 tons. **Armor:** Belt, 5 inches; turrets, 9 inches to 5 inches; barbettes, 7 inches to 4 inches; deck, 4 inches to 1½ inch. **Armament:** Four 10-inch 40-caliber guns; sixteen 6-inch 50 caliber guns; twenty-two 3-inch guns; twelve 3-pounders; fourteen small guns. **Torpedo Tubes,** four 21-inch.

ARMORED CRUISER "TENNESSEE." ALSO "WASHINGTON," "MONTANA," AND "NORTH CAROLINA."

PROTECTED CRUISER "CHARLESTON"—CLASS OF THREE SHIPS.

We have recently added to the navy three protected cruisers which, in view of developments since the Japanese war, are of doubtful value. These are the "Charleston," built at Newport News; the "Milwaukee," built at San Francisco; and the "St. Louis," built by Neafie & Levy, of Philadelphia. In view of the size of these ships, 9,700 tons, it is unfortunate that they should be so poorly protected. Their armor plans show a protective deck only 2 to 3 inches in thickness, and a partial belt of 4-inch armor, with 4-inch armor for the protection of the central battery. The ships carry each fourteen 6-inch 50-caliber guns, one mounted forward, one aft behind shields, and the other twelve being carried on the gun and main decks within the central battery. The vessels have made speeds of slightly over 22 knots on trial, which is half a knot above the contract requirement. Fifteen hundred tons of coal can be stored in the bunkers. The fighting value of these ships is small; though they are no worse than the contemporary British ships of the "County" class, several of which have visited our eastern harbors in recent years. In a modern engagement, these vessels would be quite unable to engage the up-to-date cruisers of some foreign navies, and against ships of their own type they would be terribly cut up by shell fire of the rapid-fire batteries. They will be useful for scouting purposes; but could engage only ships as poorly protected as themselves.



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Displacement, 9,500 tons. **Speed,** 22 knots. **Bunker Capacity,** 1,500 tons. **Armor:** Belt, 4 inches; topsides, 4 inches; deck, flat, 2 inches; slopes, 3 inches. **Armament:** Fourteen 6-inch R. F.; eighteen 3-inch R. F.; twelve 3-pounder semi-automatics; four 1-pounder automatics; two 3-inch field guns; two .30-caliber machine guns; eight .30-caliber automatics. **Complement,** 564.

SEMI-ARMORED CRUISER "CHARLESTON." ALSO 'MILWAUKEE" AND "ST. LOUIS."

UNARMORED CRUISER "CHATTANOOGA" AND CLASS.

The Congress of 1899 authorized the construction of six small unarmored cruisers, which are known as the "Chattanooga," "Cleveland," "Denver," "Des Moines," "Galveston," and "Tacoma." These vessels were designed to serve as "station ships"; that is to say, their duty, in times of peace, is mainly to cruise on foreign stations, and in time of war perform various naval duties which would not call for vessels of either great speed or serious fighting power. To this end they were designed with roomy quarters for the officers and men, and particular attention was paid to the various requirements of long cruises in foreign waters, where the opportunities for docking and refitting are limited. To enable them to keep the sea for lengthy periods, they are sheathed with wood and copper. They are just under 300 feet in length, 44 feet in beam, and have a draft of 15 feet 9 inches for a displacement of 3,200 tons. The protection consists of a deck 5/16 of an inch on the flat and 2½ inches on the slope. The "Des Moines," of which we present an illustration, built by the Fore River Company, made 16.6 knots on her trials. She carries a maximum supply of 700 tons of coal, which is sufficient for 7,000 miles of cruising at 10 knots speed. Each ship mounts ten 5-inch 50-caliber guns, and twelve smaller guns. The former

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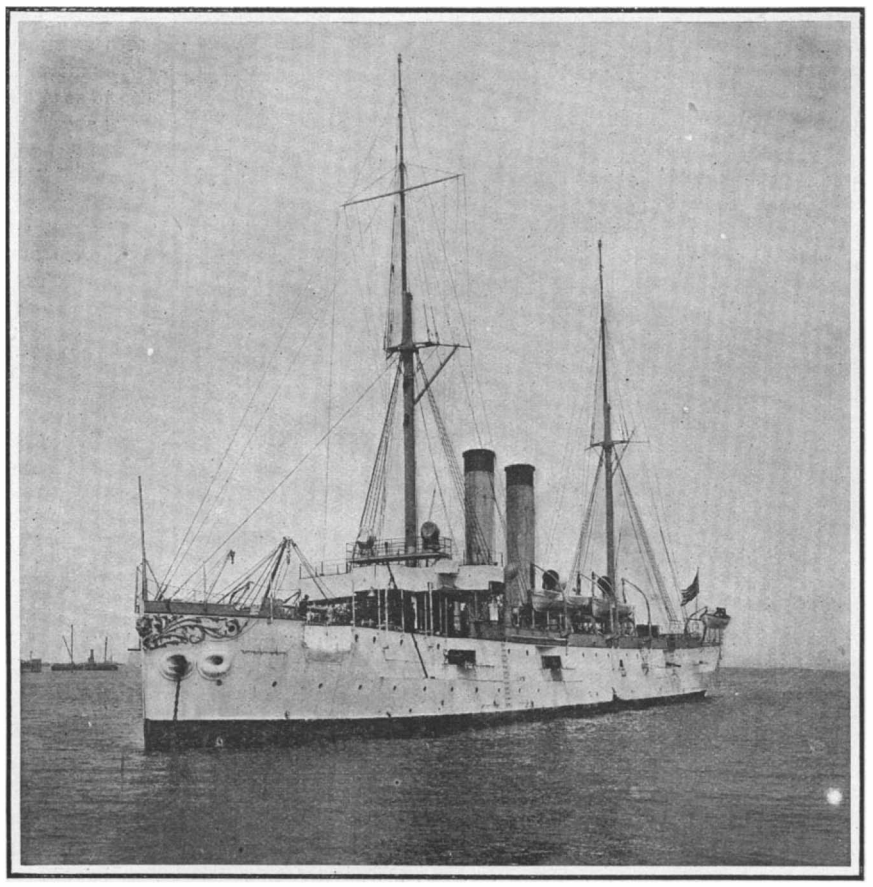
are mounted, two on the main deck, one forward and one aft protected by shields, and eight on the gun deck in broadside. The complement is 293 officers and men.

THE SCOUT CRUISER "SALEM" AND CLASS.

There are now under construction for our navy three vessels of an entirely new class, which are expected to prove a very serviceable type. These are the scout cruisers "Birmingham" and "Salem," building at Fore River, and the "Chester," building at the Bath Iron Works. As they are not designed to do any fighting, except in an emergency, the effort of the designers has been to make them fast and thoroughly seaworthy. To this end they are provided with a lofty forecastle deck; and although they are but of 3,750 tons displacement, they are being fitted with engines of 16,000 horse-power, with which they must develop a speed of 24 knots. With a view to obtaining data as to the relative efficiency of the three types of engine, the "Birmingham" is being fitted with twin-screw reciprocating engines, the "Chester" with four-screw Parsons turbines, and the "Salem" with twin-screw turbines of the Curtis type. The armament consists of twelve 3-inch rapid-fire guns and two 21-inch submerged torpedo tubes. One excellent feature of these boats is the large coal supply, of 1,250 tons, which is expected to give them a radius of action larger than that of contemporary scouts of other navies.



Displacement, 3,200 tons. **Speed,** 16½ knots. **Bunker Capacity,** 700 tons. **Armor:** Deck, ½ inch on flat, 1 inch to 2 inches on slopes. **Armament:** Ten 5-inch R. F.; eight 6-pounders: two 1-pounders; four Colts; one 3-inch field gun. **Complement,** 293.

SEMI-PROTECTED CRUISER "DES MOINES." ALSO "CLEVELAND," "CHATTANOOGA," "DENVER," "GALVESTON," AND "TACOMA."

THE TRUE SIGNIFICANCE OF THE PACIFIC CRUISE.

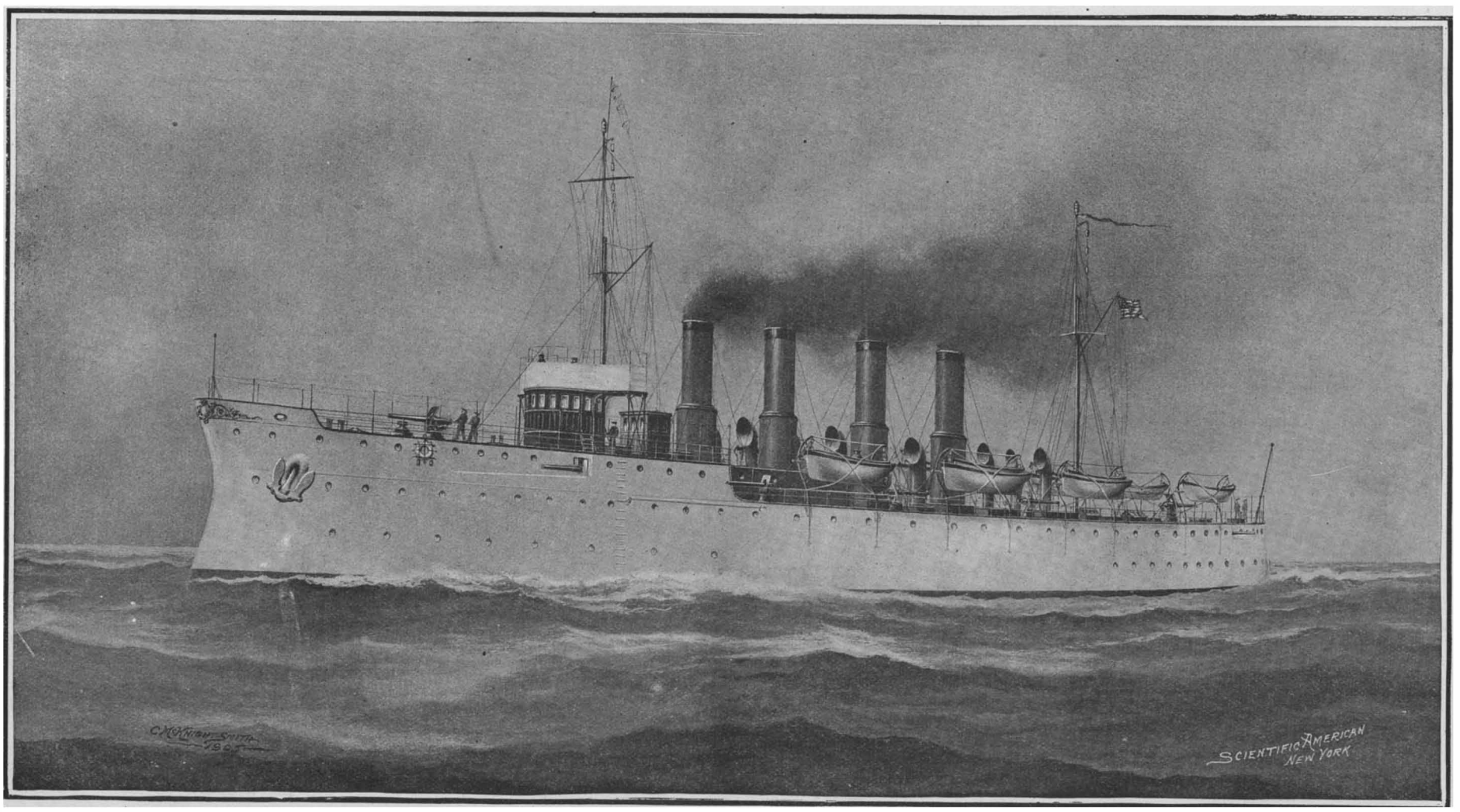
(*Continued from page 407.*)

on a speed trial with picked coal and firemen, but that which loses no time because it never misses opportunity. At the end, when he came off Brest, out of the dozen ships with him, all but two were turned over to the admiral there commanding, ready for any call; to blockade or to fight. Of the two, one, worn out structurally, he had retained from the first chiefly because of her value as a fighting unit, due to an exceptional captain; the other, his own flagship, had been over two years from a home port, yet within a month of arrival sailed again for his last battle. Compared to these its antecedents, Trafalgar is relatively a small matter.

The example is for all time. Incidental conditions have changed since then, but the essential problem remains. Steamers may not find in a calm, or in an unprofitable head wind, the propitious moment for clearing a storeship, or running into a near port to fill with water; but the commander-in-chief may find imposed upon him the consideration: Where should we fill with coal, and to what extent beyond the bunker capacity, in order to make the successive coalings, and the necessary stretches from point to point, most easy and most rapid? What distribution of these operations will make the total voyage shortest and surest? What anchorages may be available outside neutral limits, should neutral states consider coal renewal and other refreshment an operation of war not to be permitted within their jurisdiction? What choice is there among these anchorages, for facility due to weather? If driven to coal at sea, where will conditions be most propitious? For concrete instances: How much of the wide and shoal estuary of the La Plata is within neutral jurisdiction? Is the well-known quietness of the Pacific between Valparaiso and the equator such that colliers can lie alongside while the ships hold their course? If so, at what speed can they move? Then the mere operation of transferring the coal, or other stores, under any of these circumstances is done more rapidly the second time than the first; and the third than the second. At what points of the voyage should additional colliers join, having reference, not only to the considerations above mentioned, but also to the ports whence they sail, that the utmost of their cargo may go into the fleet and the least be expended for their own steaming? It is always well to consider the worst difficulties that may be met. From the north tropic on the one side to the same latitude on the other, the whole voyage of an American fleet will be in foreign waters, except when on the ocean common. Upon what hospitality can it count in war?

I hold it to be impossible that a fleet under a competent commander-in-chief and competent captains—not to mention the admirable junior official staff of our navy, of highly trained officers in the prime of life—can make the proposed voyage once, even with the advantages of peace, without being better fitted to repeat the operation in war. No amount of careful pre-arrangement in an office takes the place of doing the thing itself. It is surely a safe generalization, that no complicated scheme of action, no invention was ever yet started without giving rise to difficulties which anxious care had failed to foresee. If challenged to point out the most useful lesson the fleet may gain, it may be not unsafe to say: its surprises, the unexpected. If we can trust press reports, surprise has already begun in the home ports. The fleet apparently has not been able to get ready as soon as contemplated. If so, it will be no small gain to the government to know the several hitches; each small, but cumulative.

In my estimation, therefore, the matter stands thus: In the opinion of Sir Charles Dilke—than whom I know no sounder authority, because while non-professional he has been for a generation a most accurate observer and appreciative student of military and naval matters—the United States navy now stands second in power only to that of Great Britain; but it is not strong enough to be divided between the Atlantic and Pacific coasts. Both are part of a common country; both therefore equally entitled to defense. It follows inevitably that the fleet should be always ready, not only in formulated plan, but by acquired experience, to proceed with the utmost rapidity—according to the definition of mobility before suggested—from one coast to the other, as needed. That facility obtained, both



Length, 420 feet. **Beam,** 46 feet 8 inches. **Trial Draft,** 16 feet 10 incnes. **Depth Amidship,** 36 feet 6 inches. **Displacement on Trial,** 3,750 tons. **Battery,** twelve 3-inch guns. **Torpedo Tubes,** two submerged. **Armor:** Deck, 1½ inch, side, 2 inches. **Horse Power,** 16,000. **Speed,** 24 knots. **Coal Supply,** 1,250 tons.

SCOUT CRUISER "SALEM." CLASS OF THREE SHIPS.

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coasts are defended in a military sense. By this I do not mean that an enemy may not do some flying injury—serious injury—but that no large operation against the coasts of the United States can prosper, unless the enemy command the sea; and that he cannot do, to any effect, if within three months a superior United States force can appear. Rodjestvensky took longer; but could he have smashed Togo, as Togo did him, what would have been the situation of Japan, for all the successes of the preceding fourteen months? Evidently, however, the shorter the transit from the Pacific to the Atlantic, the greater will be the power of the fleet for good; just as it would have been better if Rodjestvensky—assuming his success—had come before Port Arthur fell, or better still before its fleet was destroyed. Such mobility can be acquired only by a familiarity with the ground, and with the methods to be followed, such as Nelson by personal experience had of the Mediterranean and of the West Indies; of the facilities they offered, and the obstacles they presented. Such knowledge is experimental, gained only by practice. It is demonstrable, therefore, that the proposed voyage is in the highest degree practical; not only advisable, but imperative. Nor should it be a single spasm of action, but a recurrent procedure; for admirals and captains go and come, and their individual experience with them. Why not annual? The Pacific is as good a drill ground as the Atlantic.

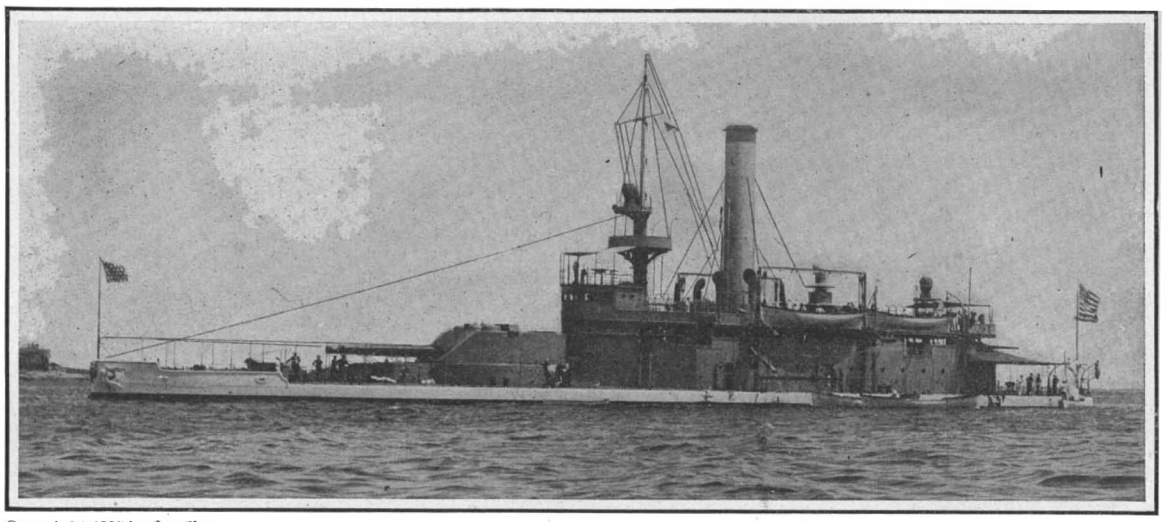
Paper from Peat.

In the report of United States Consul R. S. S. Bergh, of Gothenburg, Sweden, it is announced that paper making from peat has been begun in Sweden on a commercial scale. A company capitalized at over a million has acquired possession of extensive peat bogs, and has prepared plans for mills to turn out wrapping paper and pasteboard. Although the money for the enterprise was largely put up in London, the process by which the vegetable fiber of the peat is to be turned into paper is covered by an American patent. It is claimed that the cost of a ton of paper worth $30 is but $15, leaving a more than satisfactory margin of profit. Further claim is made that but two hours are required to convert peat into paper. This process, however, will not do away with the use of wood pulp entirely, since only the rougher kinds of wrapping paper and cardboard can be economically made. Coarse papers and cardboards made from peat possess greater strength than similar articles in which straw is the basis. The supply of peat in the world is practically inexhaustible. It is found in all the countries of northern Europe, where it has been used for centuries as a fuel. It is not unusual to discover deposits many miles in extent and from ten to fifty feet deep. Siberia alone possesses thousands of square miles of this material, and much is known to exist in the United States and Canada. If it helps to produce the coarser grades of paper and thus relieves the pressure upon the timber supply, it will do a great deal toward aiding in the preservation of the forests of the United States.

The output of coal in Peru in 1906 was 79,900 tons, as against 75,300 tons in the previous year. The output of oil increased from 50,000 tons to 71,000 tons. The greater bulk of the coal was raised in the Cerro de Pasco district. The copper output showed an increase over the previous year, and amounted to 13,500 tons, this figure including ingots, mattes, and mineral.

HARBOR-DEFENSE MONITORS.

The great scare which took place along our seaboard cities when it was known that the Spanish fleet had started for America was no doubt largely responsible for the authorization by Congress in 1898 of four harbor defense monitors, one of which, the "Arkansas," built at Newport News, is herewith illustrated. The others, the "Florida," "Nevada," and "Wyoming," were built at Elizabethport, Bath, Me., and San Francisco. The "Arkansas" is 252 feet long, 50 feet beam, and draws only 12 feet 6 inches of water. She is a typical monitor, with a freeboard of only a few feet and her main battery of two 12-inch guns is carried at a height of not more than 8 or 10 feet above the water. The belt, 11 inches in maximum thickness, is 5 feet wide, half of this being below the water line. The deck is 1½ inches thick and the barbette and turret are protected by 11 inches of armor, all treated by the Krupp process. In each corner of the superstructure is mounted a 4-inch, 50-caliber gun. The vessels have a speed of 12 knots in smooth water. They are purely harbor defense vessels, and in any but a comparatively smooth sea it would be difficult to make accurate shooting with the big guns. Steaming head to sea the decks are constantly submerged, and it would be a problem under such conditions to keep the water out of the turrets. It is certain that no more ships of the monitor type will be constructed for the United States navy.



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Displacement, 3,235 tons. **Speed,** 12 knots. **Bunker Capacity,** 400 tons. **Armor:** Belt, 11 inches; turrets, 11 inches; barbettes, 11 inches; deck, 1½ inch. **Armament:** Two 12-inch 40-caliber B. L.; four 4-inch R. F.; three 6-pounders; six 1-pounders; two Colts. **Complement,** 137.

HARBOR-DEFENSE MONITOR "ARKANSAS." ALSO "FLORIDA," "WYOMING," AND "NEVADA."

New Forest Reserves Created.

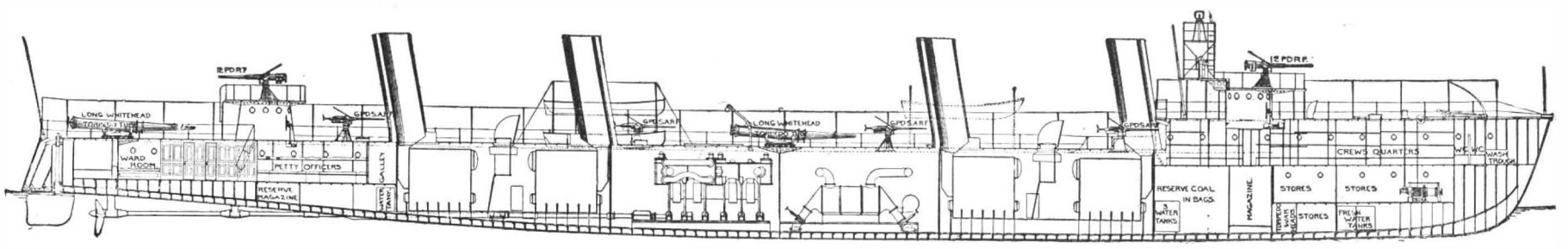
President Roosevelt has recently created four new bird and animal reserves on the Pacific coast, as well as increasing certain forest reserves. The action was the outcome of the campaign undertaken by the National Association of Audubon Societies, to prevent the extermination of the sealion and of certain birds inhabiting the small islands along the northwestern Pacific coast. One of the reserves on the coast of Oregon embraces a number of rocky islets which are worthless for any other purpose. In spite of this fact, they are inhabited by a vast number of sea birds. The remaining three reserves are in the waters of the State of Washington and include islands, some being at the entrance to Puget Sound, while the others are on the southwestern coast of the State near the Oregon line.

In forest preserves 480,451 acres have been added to the Stanislaus and Lassen Peak national forests in California, the addition to the Stanislaus forest lying in Calaveras, Tuolumne, and Mariposa counties. The strip of land is 55 miles long and covers 348,570 acres. The northern part of this addition takes in the famous Calaveras grove of big trees, which is owned privately. The other smaller adjacent groves have given to the government the intention of buying the patented land.

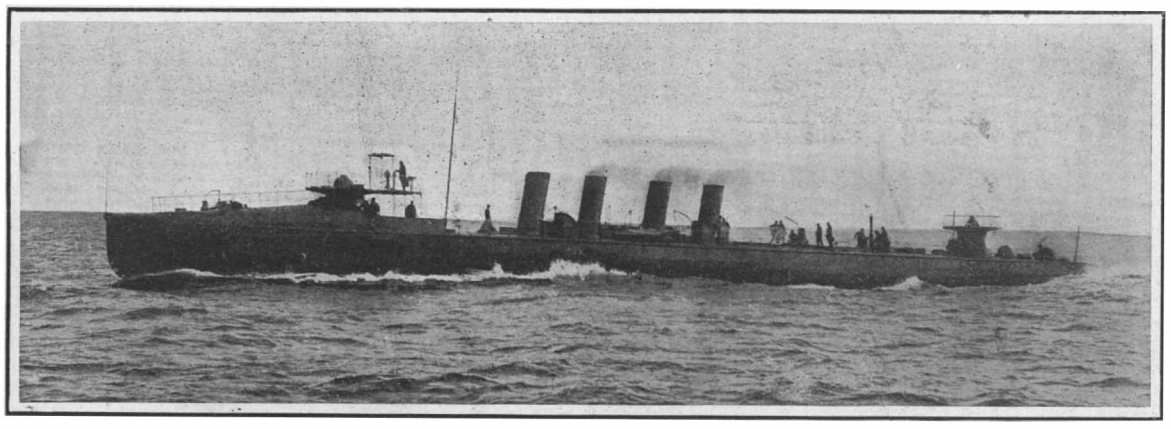
TORPEDO-BOAT DESTROYERS.

At the time of the Spanish war the United States possessed no torpedo-boat destroyers; but the Congress of 1898 authorized on May 4 the construction of sixteen of these vessels. The contracts were signed in the following autumn, and it was not until some four years later that these boats went into commission. The accompanying photograph of the "Macdonough" shows the characteristic features of these craft. They vary in displacement from 408 to 482 tons, on a mean draft of from 6 feet to 7 feet 2 inches; but the full load displacement is considerably greater, varying from 512 to 692 tons. The "Macdonough" is 240 feet 7 inches long, 22 feet 3 inches extreme beam; her mean draft is 6 feet 8 inches; her normal displacement 430 tons, and her full load displacement 512 tons. She is driven by twin-screw triple-expansion engines. Steam is supplied by Thornycroft boilers. Her highest speed on trial was 28 knots on a mean displacement of 400 tons, and this was obtained with an indicated horse-power of 6,425. Her bunker capacity is 110 tons. The lowest speed obtained on trial by any of these boats was 28.1 knots and the highest 29.69 knots, which was the speed of the "Stewart." It cannot be said that our destroyers have been very successful. During last summer a race was arranged from Sandy Hook to Hampton Roads, in which several of the boats broke down and the winners fell far below their trial speeds. It is believed by our naval constructors that it is wiser to build larger and stronger boats with greater cruising radius, and be satisfied with a moderate speed of from 24 to 25 knots. It is claimed that such boats could repeat their trial speed in actual service under any but the most extreme conditions, and that they would be free from the ever-recurring breakdowns which render our present destroyers so unreliable. Hence the present intention of the government is to build five 800-ton destroyers in which the weights allotted to hull and engines will be sufficient to render them serviceable in any kind of weather. These boats are to be driven by Parsons turbines. We think it would be wise to add to the displacement, and raise the speed to at least 30 knots.

We have also added to the navy 22 torpedo boats of from 150 to 340 tons displacement, and of from 23 to 30 knots speed, the particulars of which are given in the tabular summary of the navy on another page.



LONGITUDINAL SECTION, SHOWING INTERNAL ARRANGEMENTS OF TORPEDO-BOAT DESTROYERS.



Length, 240 feet 7 inches. **Beam,** 22 feet 3 inches. **Draft,** 6 feet 8 inches. **Displacement,** 430 tons. **Horse Power,** 6,425. **Speed,** 28 knots.

TORPEDO-BOAT DESTROYER "MACDONOUGH." CLASS OF SIXTEEN VESSELS.

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WARSHIP TONNAGE OF THE PRINCIPAL NAVAL POWERS.

On a given amount of displacement, two competent naval architects will produce two ships which, while they may differ very widely in details, are apt to represent about the same amount of military efficiency in the total. What one gains in gun power, the other will exhibit in superior armor protection. Where one excels in speed the other will show great endurance or cruising radius, and so on. And if in estimating the strength of two navies by displacement a proper deduction be made of obsolete ships, and only those be included in the comparison which have real fighting value, a fairly accurate rough-and-ready estimate of relative power may be obtained. This is the principle of comparison which has been followed by the Office of Naval Intelligence of the Navy Department in a table which they have just issued showing the comparative warship tonnage of the principal naval powers. It is simply a statement of the total displacement of all the ships of each navy without taking any account of the particular design of the individual ships which make up that total. It includes all the ships actually constructed of a thousand tons or more displacement, and all the torpedo craft of more than fifty tons. The vessels excluded from this comparison are as follows: Those over twenty years old unless they have been reconstructed and rearmed since 1900; transports, colliers, repair ships, torpedo-depot ships, converted merchant vessels or yachts; vessels of less than 1,000 tons, except torpedo craft of less than 50 tons. With reference to the table summarizing the number of ships of each class possessed by the navy, it should be noted that battleships of the first class are those of about 10,000 tons or more displacement; that under the head of cruisers are included all unarmored cruising vessels above 1,000 tons displacement; and that under coast-defense vessels are included the small battleships and monitors, regarding which it should be noted that no more vessels of this class are being proposed or built by the great powers.

VESSELS BUILT JUNE 1, 1907.

	Battleships.*	Armored Cruisers.	Cruisers.†	Destroyers.	Torpedo Boats.	Submarines.	Coast Defense Vessels.‡
England	52	32	90	142	47	39	0
France	19	19	28	35	257	41	12
United States	22	10	41	16	32	12	11
Germany	22	8	38	60	48	1	8
Japan	11	11	19	54	77	7	3
Russia	5	4	15	93	57	25	4
Italy	10	6	11	13	66	3	0
Austria	3	3	5	4	36	0	6

* Battleships, first-class, are those of (about) 10,000 tons or more displacement.

† Includes all unarmored cruising vessels above 1,000 tons displacement.

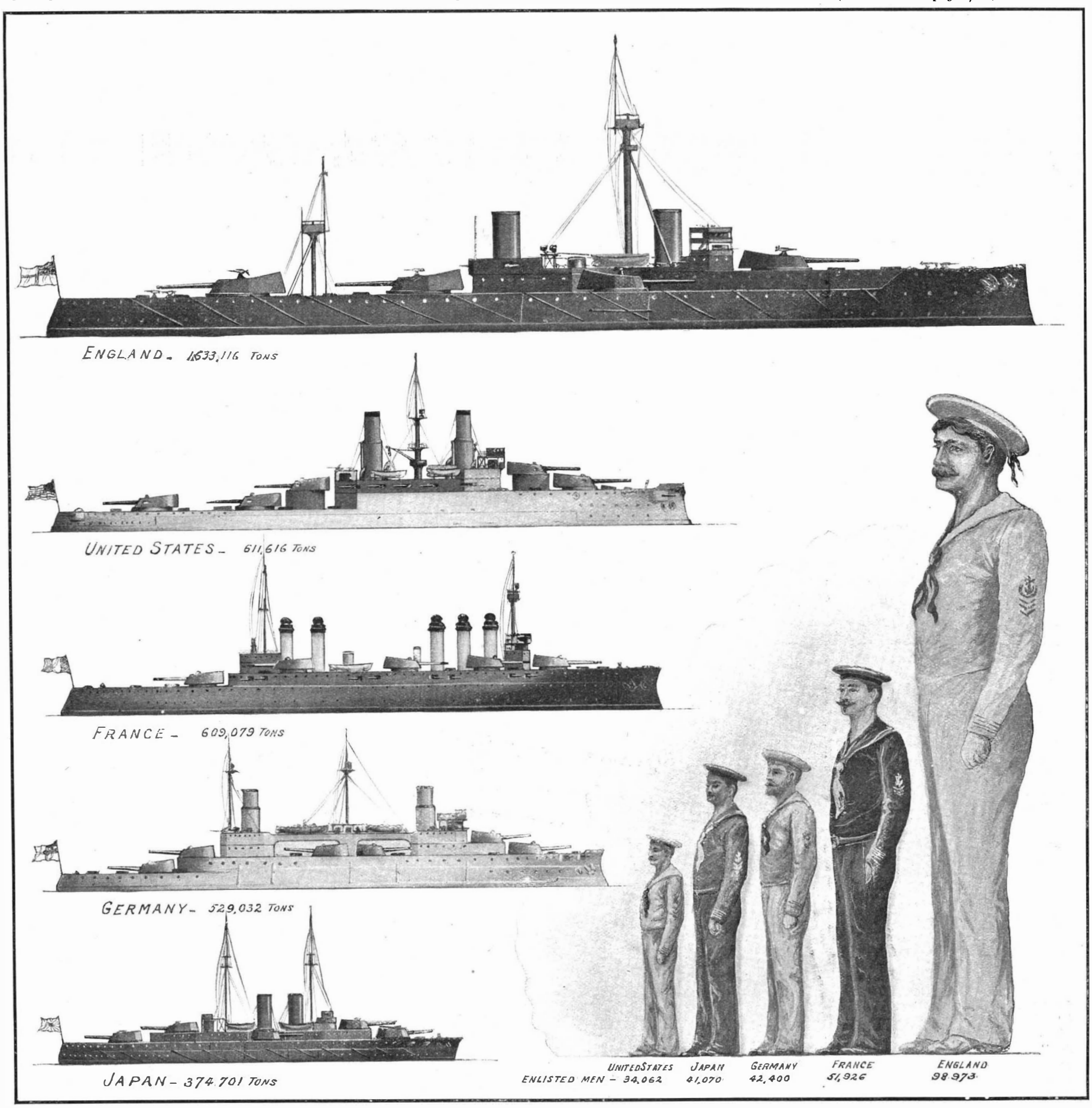
‡ Includes smaller battleships and monitors. No more vessels of this class are being proposed or built by the great powers.

It should also be noted that in making comparisons of naval strength, and particularly of naval increase, the fact should be taken into consideration that the rapidity of construction varies greatly in different countries. In England, Germany, and Japan, the battleships and armored cruisers are completed in from two to three years; in the United States, from three to four years; and in France, Italy, and Russia, not less than four years are required.

It will be seen from the accompanying diagram that Great Britain continues to hold her commanding lead among the naval powers, with a total tonnage of 1,633,116, which is two and two-thirds as much as that of the second power, which is the United States with 611,616 tons. France comes third with 609,079 tons, Germany fourth with 529,032 tons, and Japan fifth with 374,701 tons. If all the vessels at present building were completed, France and the United States would change places, the position of the other powers remaining the same. Great Britain would have 1,821,610 tons, France 836,112 tons, the United States 771,758 tons, Germany 680,602 tons, and Japan 451,320 tons.

Some ingenious and more or less reliable estimates of naval strength have been made, in which the ships are estimated according to a system of points, so much for guns, so much for armor, so much for speed, with a certain percentage of reduction for age; and, undoubtedly, this is the true way to institute the comparison. But even here, the result is not conclusive; for the reason that it takes no account whatever of

(*Continued on page 431.*)


ENGLAND - 1633,116 TONS
UNITED STATES - 611,616 TONS
FRANCE - 609,079 TONS
GERMANY - 529,032 TONS
JAPAN - 374,701 TONS
UNITED STATES JAPAN GERMANY FRANCE ENGLAND
ENLISTED MEN - 34,062 41,070 42,400 51,926 98,973

COMPARATIVE STRENGTH OF LEADING NAVAL POWERS IN SHIPS AND ENLISTED MEN

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THE UNITED STATES NAVAL ACADEMY.

BY LIEUTENANT-COMMANDER EDWARD L. BEACH, U. S. N.

IN the Naval Academy at Annapolis the government has spent $10,000,000 in the last nine years, with the result that the school now has magnificent massive stone buildings designed to last for all time. The most important building is Bancroft Hall, where the midshipmen are quartered and mess. In the center of this, facing Chesapeake Bay, is the beautiful Memorial Hall, considered by competent architects to be of exquisite design. On one end of Bancroft Hall is the Armory, on the other end the Seamanship and Gymnasium building. These are all buildings of huge dimensions, and yet form but different parts of one main building.

In viewing these structures one is impressed by the ambitious arches of the Armory, and the ornamentation of the exterior of all this stone work.

The next in importance is the Academic building. In this are the library, the auditorium, class and lecture rooms, the educational electric plant, the chemical laboratories. The front of the Academic building is especially beautiful.

Next comes the Steam Engineering building, of enormous size This includes the machine shop, foundry, and other shops and rooms.

The Memorial Chapel with its ambitious dome is perhaps the most striking of all the buildings. In its crypt the ashes of John Paul Jones will find a worthy resting place.

The purpose of all this is to provide a place where young men may be trained for commissions in the navy. The duties devolving upon officers on shipboard determine the scope, extent, and nature of the Annapolis training.

Aboard ship officers control an organization that moves with absolute precision; they are called upon to manage and care for boilers and steam engines and their appurtenances, for electric and hydraulic and air engines, for guns, turrets, torpedoes, and explosives. They must direct the workings of large bodies of men under various circumstances, manage boats in bad weather, maneuver and navigate the ship. These required duties regulate the nature of the training at Annapolis of the young men who will soon be called upon to perform them.

Annapolis does not produce admirals and captains; higher naval training comes with service afloat under responsible duties. But the Naval Academy has a field of its own of great importance. It selects and sifts and molds the material out of which eventually high officers will be made. While at the Academy it surrounds the midshipman with naval atmosphere and tradition, and sends him to sea after four years of severe training ready to commence his life's work.

ORGANIZATION.

The Naval Academy is directly under the Chief of the Bureau of Navigation. It is in charge of the superintendent, a naval officer of the rank of commander, captain, or rear admiral. In matters of discipline affecting officers, midshipmen, and enlisted men, the superintendent is in supreme control.

Next to the superintendent in rank and authority, and in immediate charge of the midshipmen, is the commandant of midshipmen. The discipline and control of the midshipmen is the special duty of the commandant. This is done under the general direction of the superintendent, but it is only one of many duties devolving upon that officer. He is also responsible for the proper expenditure of vast sums of money, for the condition of the *matériel* as well as the personnel. There are eight hundred and fifty midshipmen now at the Academy, but there is also a vast educational plant, five warships with their crews, six torpedo boats fully commissioned, and hundreds of workmen, all coming under the superintendent's orders.

In scholastic matters affecting midshipmen, the Academic Board, corresponding to the faculty of a college, decides. This board is composed of the superintendent and the heads of the various academic departments.

These departments are as follows: Discipline, seamanship, ordnance and gunnery, navigation, marine engineering and naval construction, mathematics, physics and chemistry, electrical engineering, English studies, modern languages.

Besides the superintendent there are eighty-five commissioned naval officers and twenty-six civilian professors and instructors at the Naval Academy concerned in instructing the midshipmen. These are divided up into the different departments, there being one head and a number of assistants to each department.

Naval officers are assigned to all departments. In addition, to the departments which may be characterized as non-professional, such as the English and modern language departments, the civilian professors are detailed.

In the professional departments, such as seamanship and ordnance and gunnery, theoretical instruction is given by recitations on prescribed lessons, as well as practical instruction by varied drills pertaining to the respective departments. Thus ordnance and gunnery will have charge of all infantry and artillery, great gun, and torpedo drills; seamanship, of all boat and sail drills; marine engineering, of all shop and steam drills.

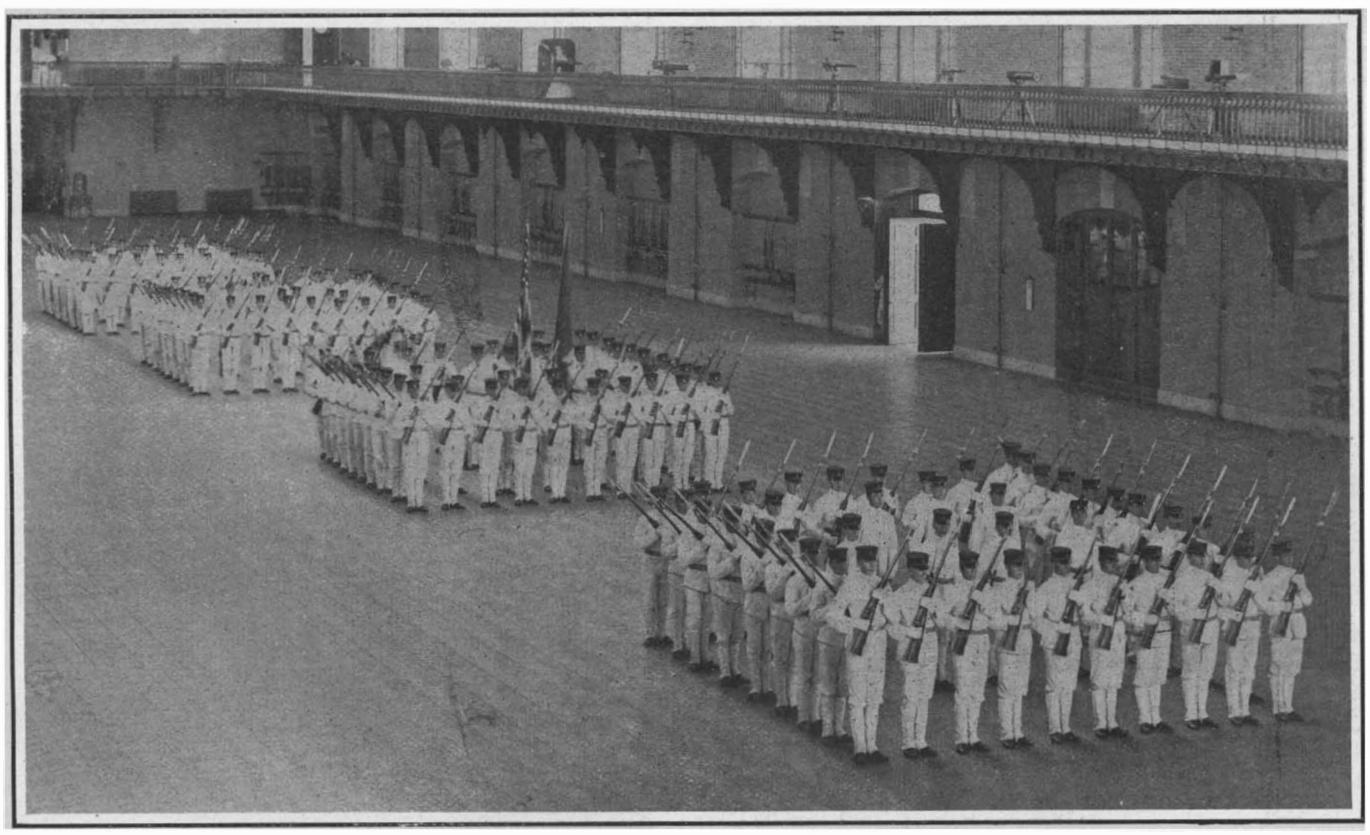
Officers ordered to the Naval Academy are always just from sea duty. Until recently there have never been more than three or four civilian instructors employed in the instruction of midshipmen. It has always been the practice to detail seagoing officers for these duties, in modern language and mathematical instruction as well as in navigation and seamanship studies. The purpose has been to surround midshipmen with nothing but a naval atmosphere, and those best qualified to do this are officers fresh from sea service; the idea is that association in a recitation room with a naval officer will be in a general way beneficial to the midshipmen, irrespective of what the officer may be teaching.

An officer's tour of duty here is two years, at the end of which time he is ordered to sea. All officers are subject to Naval Academy detail, and must be prepared to teach, not only what they have recently been practising on board ship, but also subjects that may not be so familiar. An officer ordered to Naval Academy duty does not know to which department he will be assigned, and at times the work of preparation for the next day's recitations causes many officers to burn the midnight oil.

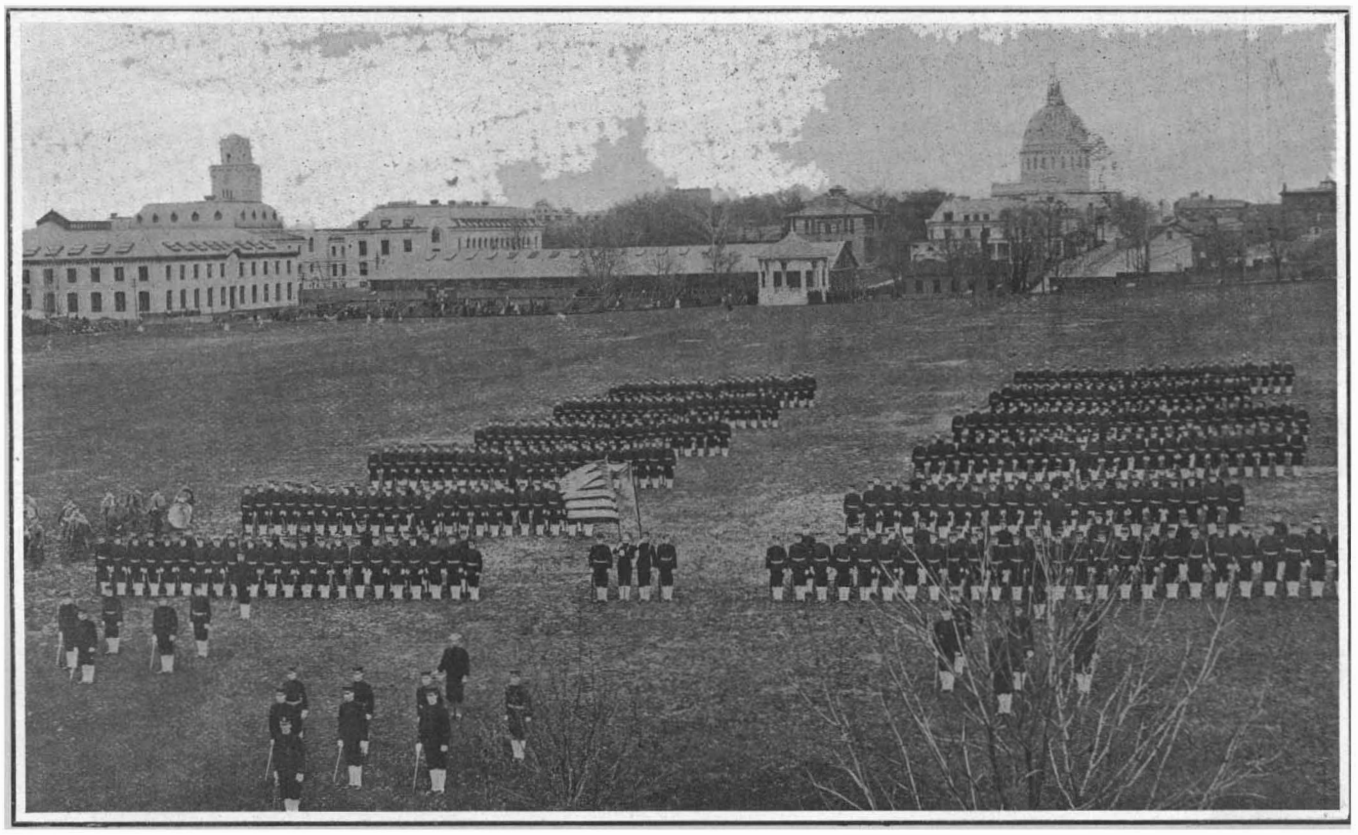
On the Academy grounds there are fifty sets of quarters provided for officers having families, and a large number of suites for bachelors in the officers' mess.

Duty at Annapolis is very pleasant, all are interested in the same thing and in each other. A civilian would inevitably soon be tired by the amount of shop that is talked, but this is natural to the naval officer where his intimates are part of the same organization, and interested in the same things he is. Social matters here are continuous throughout the year. There are balls and teas and card parties and dinners constantly oc-

(*Continued on page 431.*)



A Drill in the Armory.



The Entire Battalion on the Parade Ground.

THE UNITED STATES NAVAL ACADEMY.

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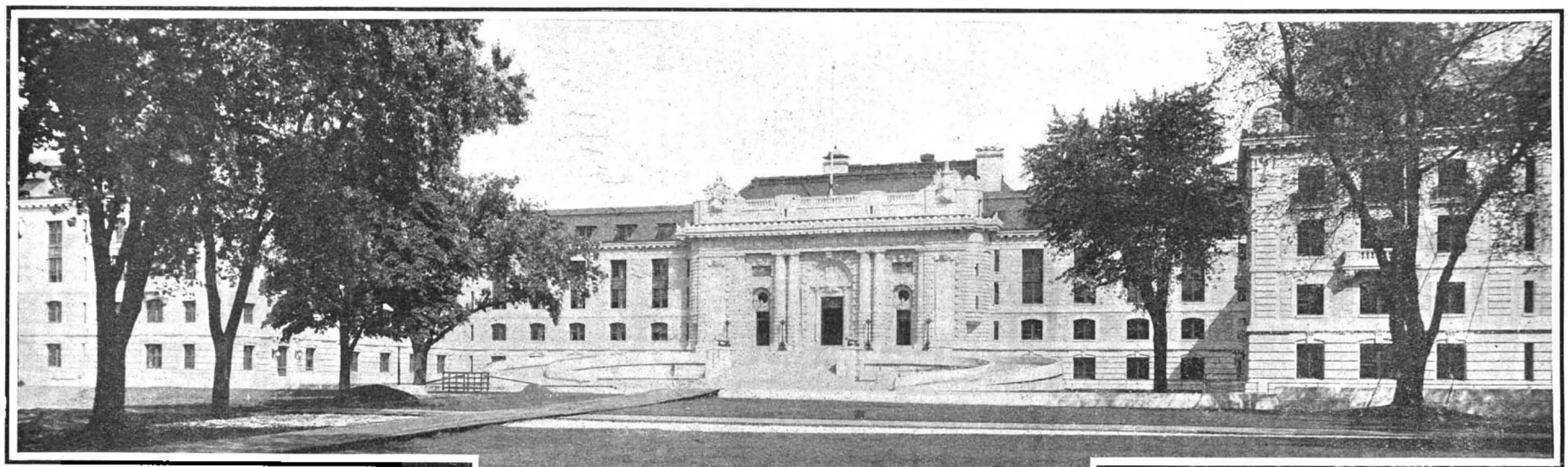
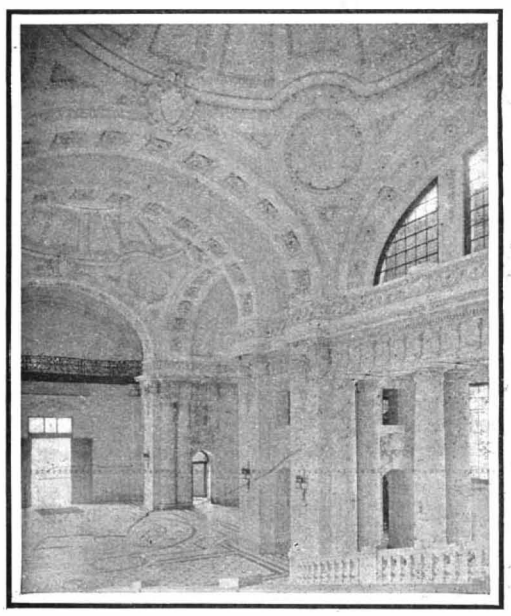
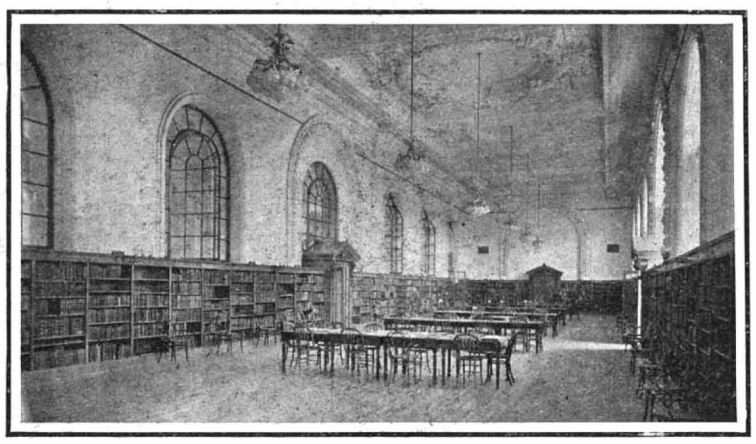


A General View of Bancroft Hall.

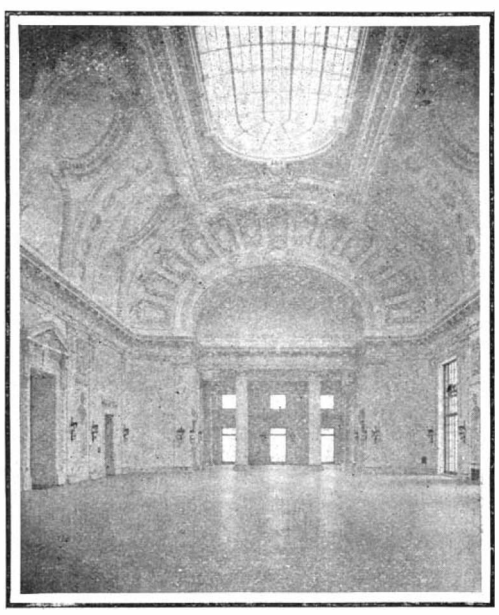
Here 850 Midshipmen Are Quartered.



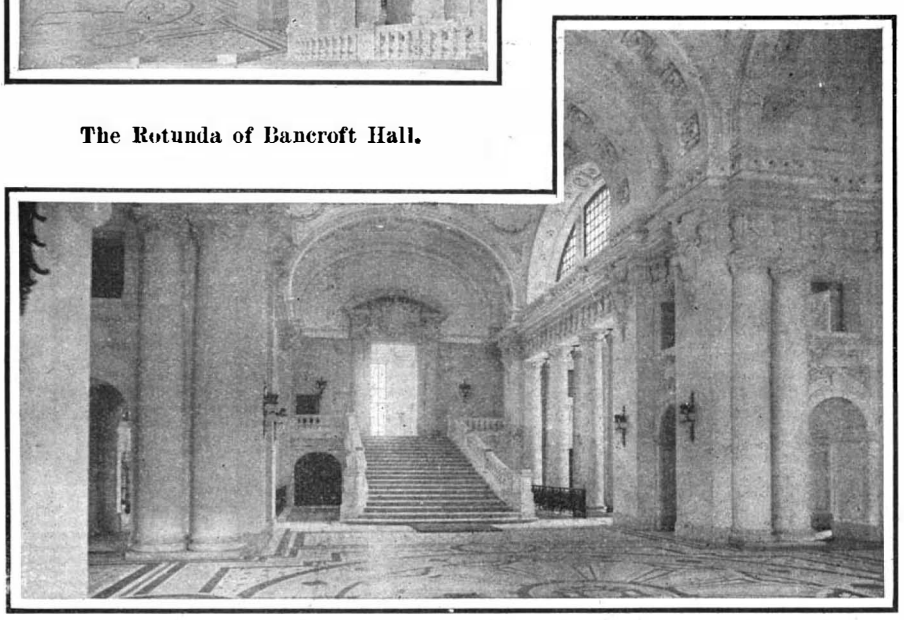
The Rotunda of Bancroft Hall.



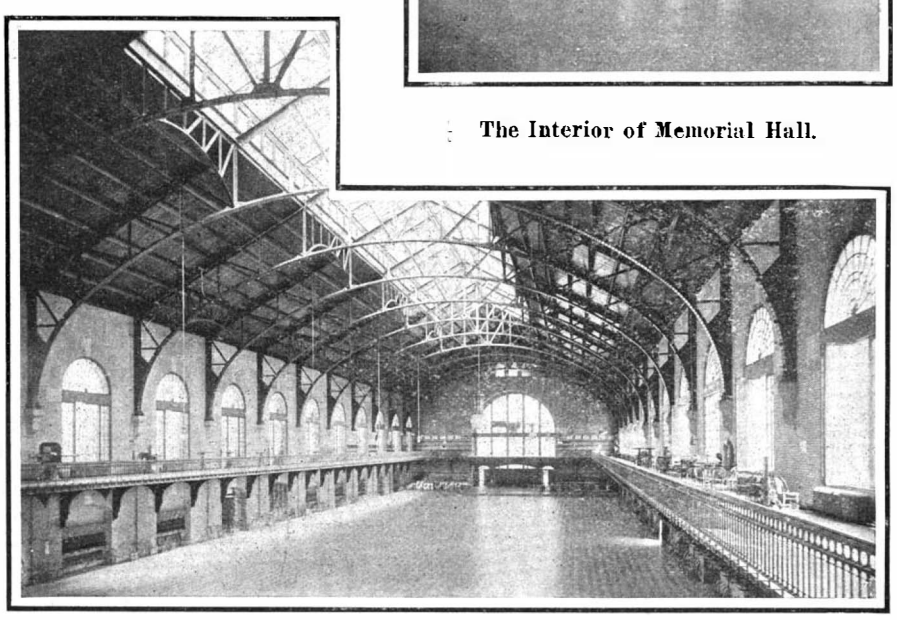
The Library. On the Shelves Are 50,000 Books.



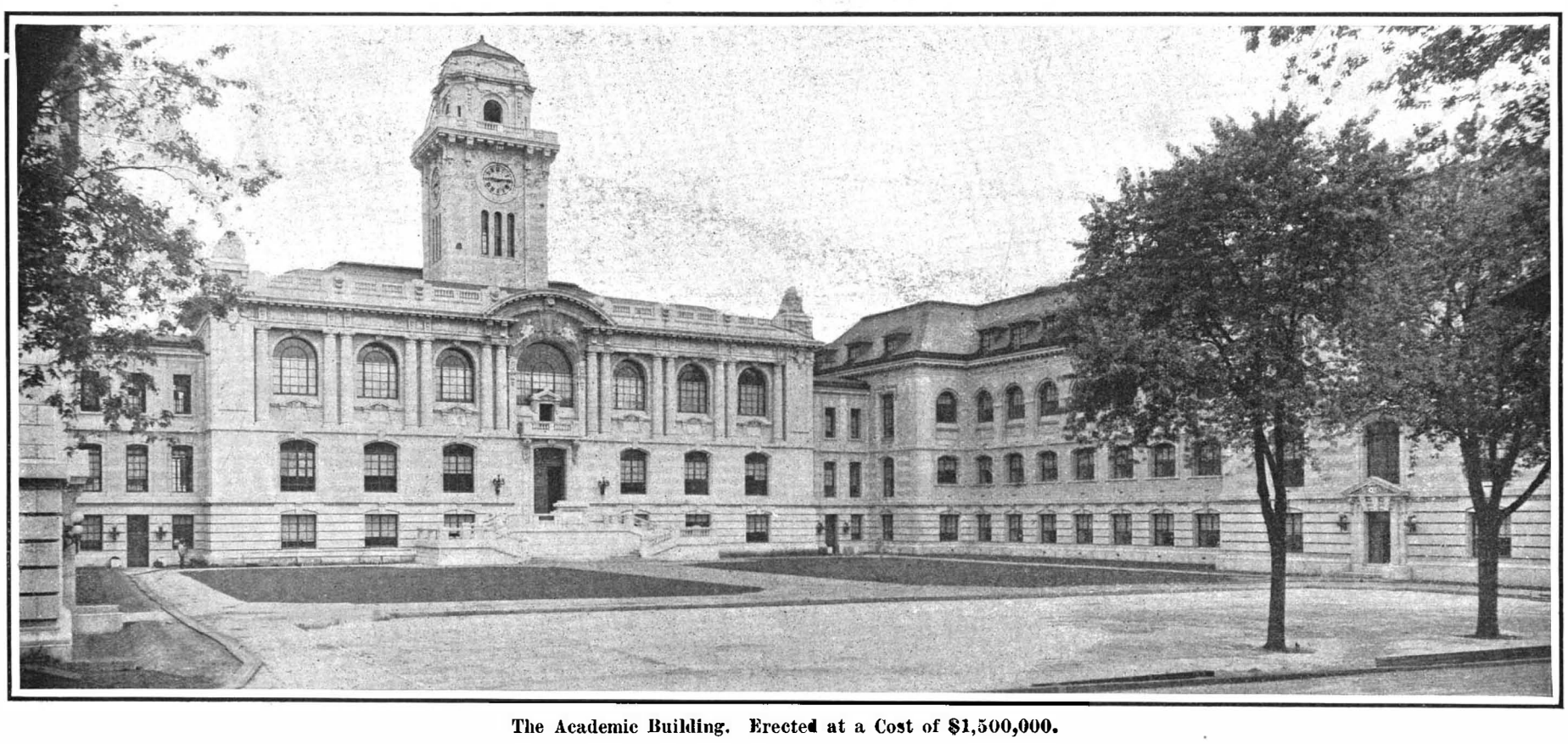
The Interior of Memorial Hall.



The Rotunda of Bancroft Hall.



Interior View of the Armory.



The Academic Building. Erected at a Cost of $1,500,000.

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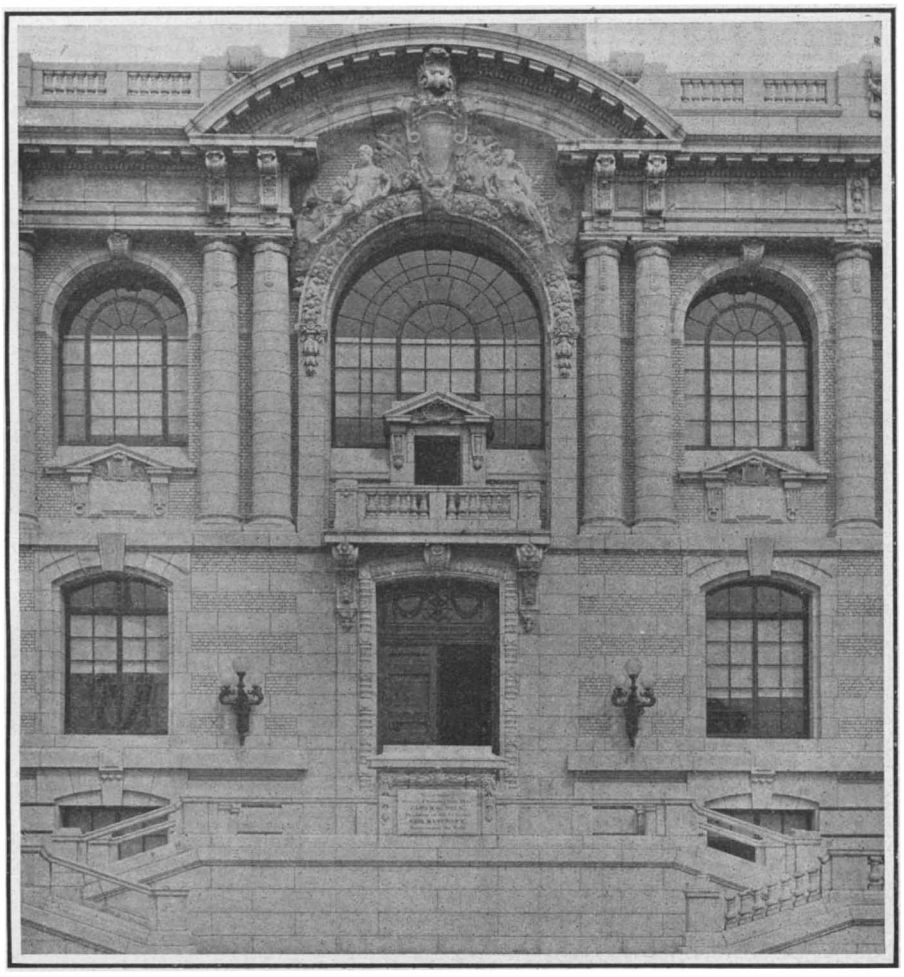
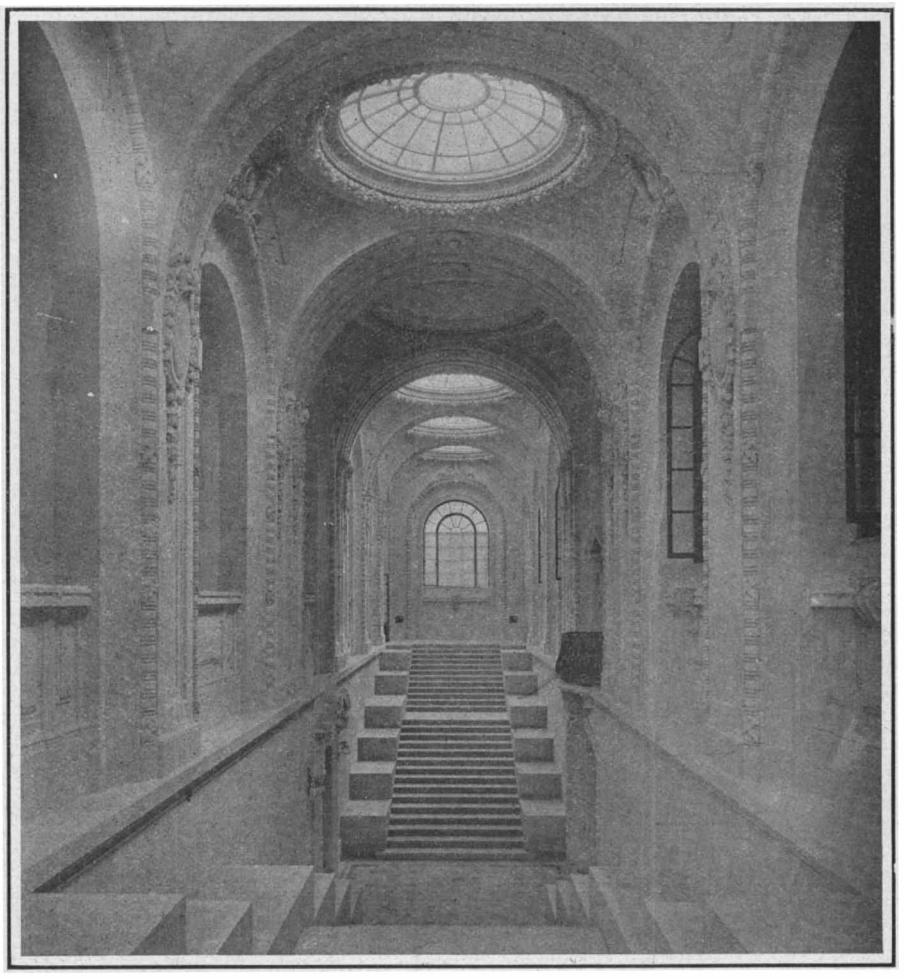
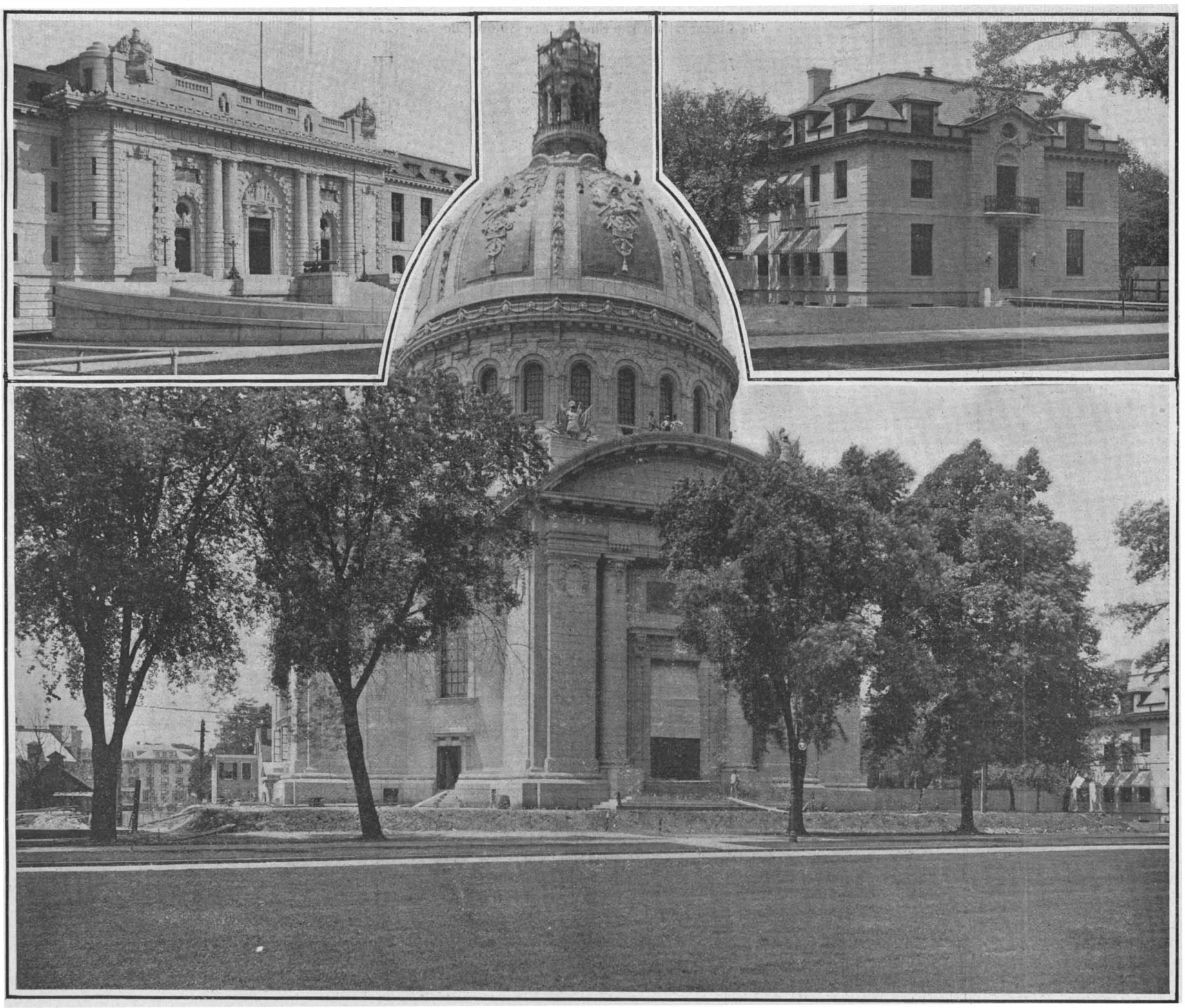


Entrance to the Academic Building.



Academic Building—Entrance to the Library.



Entrance to Bancroft Hall.

The Superintendent's Offices.

Memorial Chapel, Which Cost Over $400,000 and Is Not Yet Completed. The Crypt Will Contain Paul Jones's Body.

THE UNITED STATES NAVAL ACADEMY.

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SIMPLE EXPLANATION OF MODEL BASIN METHODS.

BY D. W. TAYLOR, NAVAL CONSTRUCTOR, U. S. N.

The primary work of an experimental model basin is the estimation, with reasonable accuracy, of the resistance and horse-power of full-sized ships from experiments with small and inexpensive models.

The first experimental model basin was built nearly forty years ago by Mr. William Froude in his garden near Torquay, England. It was soon taken over by the Admiralty. The second was built by an enterprising firm of Clyde shipbuilders at Dumbarton, Scotland, a little more than twenty years ago.

During the last ten years the number of model basins has increased rapidly. Besides England, there are now government basins in Italy, Russia, the United States, Germany, and France, and there are private basins in England, Germany, and the United States. In the United States the government basin at Washington began work in 1899. There is a private basin at the University of Michigan, and at Cornell University a canal used for hydraulic experiments is also used, to some extent, for experiments with models of ships and propellers. Existing basins are from 300 to 550 feet long, from 20 to 45 feet wide, and from 8 to 14 feet deep.

All of these experimental basins rely upon the principles first enunciated and applied in practice to vessels by Mr. William Froude. The law of Comparison, or Froude's law, as it is frequently called, teaches us that certain resistances of ships and models at corresponding speeds vary directly as their displacements. That is to say, at speeds proportional to the square roots of any similar linear dimensions (preferably length), resistances which obey Froude's law are directly as the displacements or as the cubes of similar linear dimensions. Mr. Froude demonstrated conclusively the value of his methods by showing that the actual resistance of a full-sized ship—the English naval vessel "Greyhound"—as determined by towing her, agreed very closely with resistance estimated by his methods from the resistance of a small model.

There are three main components of the resistance of a ship, viz., the skin friction, or the resistance due to the rubbing of the water on the surface; the eddy resistance, or resistance due to the formation of eddies, such as those behind stern-posts, struts, etc.; and the wave-making resistance, or the resistance due to the creation of waves as the ship advances through the water. The first and the third of these elements are the more important in practice.

The eddy resistance in properly designed ships is not great, and for practical purposes is classed with the wave-making resistance, the two combined forming what is often called the residuary resistance. It is the residuary resistance to which the law of comparison is applied directly.

The skin friction does not follow the law of comparison, but, fortunately, it can be estimated with reasonable approach to accuracy for both model and ship.

The quantities that have to be dealt with in model experiments are small, and it is necessary that the models be constructed with accuracy and tested by a reliable apparatus with much care. The majority of model basins use paraffin wax in the construction of models, following the practice originally established by Mr. Froude. Paraffin cannot be made to stand the summer heat of Washington without inadmissible change of form, so that at the United States basin wood is used as material for the models. This is more expensive, but, otherwise, has everything in its favor. It enables models 20 feet in length to be regularly used, while with paraffin from 12 to 14 feet is the greatest practicable length. Whether of paraffin or wood, a model must represent accurately to scale the under-water body of its corresponding ship and have a thoroughly smooth surface. At the Washington basin the principal shaping of the models is done by machinery, finishing touches being put on by hand.

When preparing for testing, the model is carefully weighted in the water to the exact displacement and trim corresponding to the full-sized ship, and then towed at various speeds, through recording dynamometric apparatus, from a carriage which runs back and forth, and is arranged so that it can tow models at a large number of speeds, the speed of each run being accurately determined and recorded. At the Washington basin electricity was used for the first time to drive the towing carriage. This feature has been copied in all basins of later date.

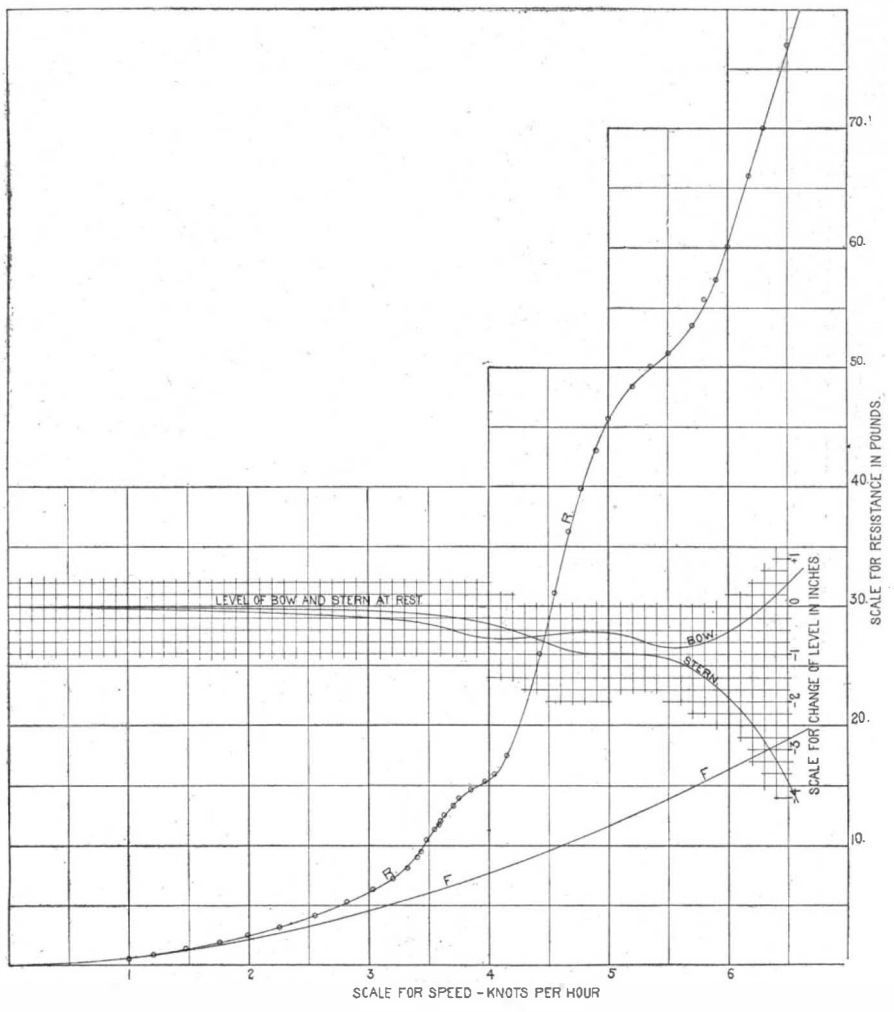

Fig. 1.—Curves of Resistance and Change of Level of Model. Length, 20 Feet; Breadth, 2.076 Feet; Draft, 0.863 Feet; Displacement, 1,694 Pounds.

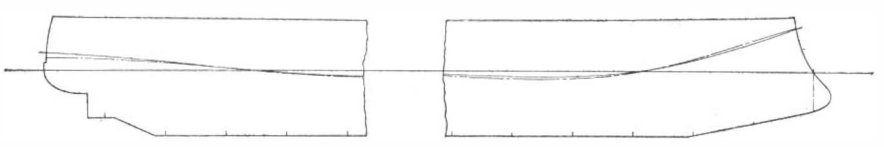

Fig. 2.—Speed of Ship About 18.5 Knots. Comparison of Wave Profile Fore and Aft Estimated from Model Runs with That Observed on Trials of Ship.

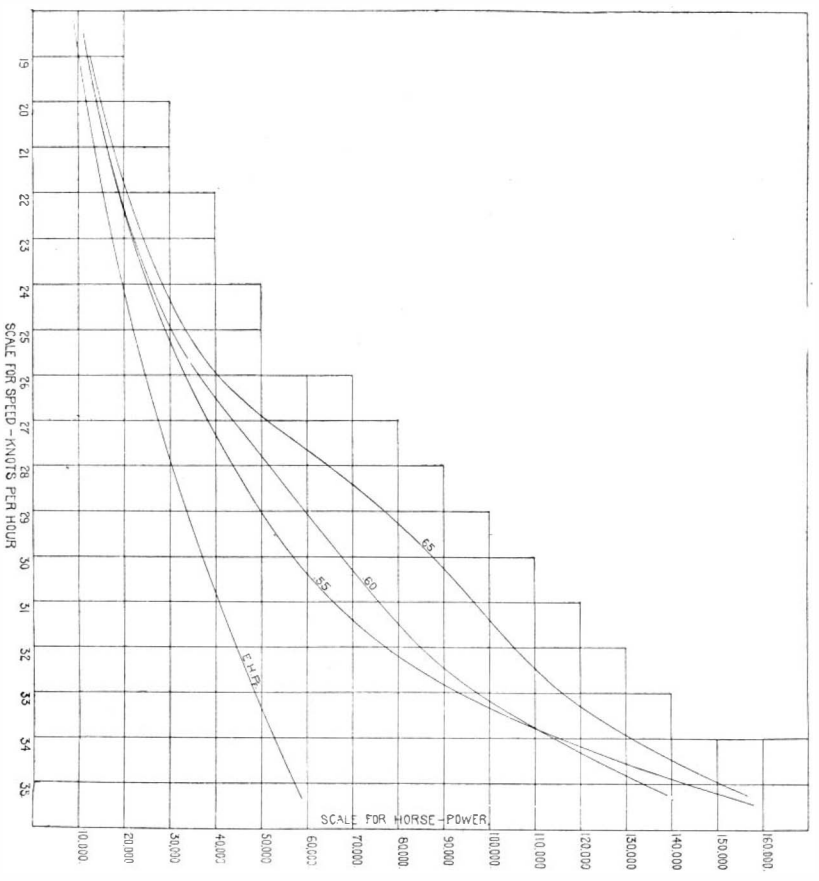

Fig. 3.—Curves of Effective Horse-Power for Ship of 40,000 Tons Displacement, 800 Feet Long and 0 55, 0.60, and 0.65 Cylindrical Coefficient.

The recorded resistances are plotted as ordinates above the speeds, thus giving a number of spots through which a fair average curve is drawn, giving the total resistance of the model.

Fig. 1 shows from an actual model test a number of spots and the resistance curve *RR* drawn through them. The model represented a collier with a long parallel middle body and was tested to a corresponding speed higher than such a vessel could obtain in service. Its resistance curve shows up well the "humps" and "hollows" which are due to the fact that at some speeds the waves caused by the bow accentuate those caused by the stern, giving a "hump," while at other speeds the waves from the bow partially neutralize those at the stern, causing a "hollow." The curves in Fig. 1 showing the change of level of bow and stern are typical. In practically every case, vessels of normal types settle bodily both forward and aft, as speed increases, with but little change of trim until, at a critical speed, which is in knots about 1.15 the square root of the length in feet (5.25 knots for a 20-foot model), the bow begins to rise sharply and the stern to settle sharply. Not many actual ships are fast enough to reach this critical speed.

The displacement, wetted surface, and all other necessary quantities in connection with the model having been calculated in advance, the first step in the reduction of the results is to plot a curve such as *FF* in Fig. 1, which, being the frictional resistance of a plane 20 feet long and having the same surface as the model, is taken as representing the frictional resistance of the model. It is important that the surface be taken as 20 feet long, because it has been found by numerous experiments that the coefficient of friction of a smooth plane surface in water varies with the length; the greater the length the smaller the coefficient of friction. The index or power of the speed according to which the friction varies also changes somewhat with the length; but for lengths such as those of actual ships the index is practically constant at 1.83.

The intercepts in Fig. 1 between the curves *RR* and *FF* give the residuary resistance. The application of the law of comparison to this residuary resistance is comparatively simple. Thus, at 4 knots model speed the residuary resistance is 7.73 pounds. Suppose the 20-foot model represents a ship 500 feet long. Then the linear ratio between model and ship is 25. The displacements are as the cube of the linear ratio, or as 15,625. Corresponding speeds will be as $\sqrt{25}$, or ship speed will be 5 times model speed. The residuary resistance of the ship in fresh water would be, then, 15,625 x 7.73, or, in round numbers, 120,800 pounds at 5 x 4 = 20 knots. As a general thing, however, while model results are obtained in fresh water, we wish to know the resistance of a ship in salt water. All resistances are taken to vary as the density of the water, which is an ample approximation. So, to obtain the resistance of the ship in salt water, we multiply 120,800 pounds by the ratio between fresh and salt water, which is 1.026. Thus we determine the residuary resistance of the ship in salt water to be 123,900 pounds.

We need still to calculate its frictional resistance. We know, by calculation, its wetted surface, and for the coefficient of friction we use Froude's or Tideman's frictional coefficients, obtained from experiments with plane surfaces many years ago, and which, it may be remarked, have been confirmed by such experiments as have been made on the subject at the United States model basin. But some experiments on large and long planes, with surfaces such as commonly presented by ships' bottoms, towed at high speeds, would be of great value.

The coefficients in use are deduced from experiments with smooth planes of comparatively small dimensions and towed at comparatively low speeds. Actual ships' bottoms are seldom as smooth as planes are made, and their dimensions are much greater than the planes hitherto tested. The needed investigation, however, would have to be car-

(*Continued on page 420.*)

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RECENTLY PATENTED INVENTIONS.

Pertaining to Apparel.

SHIRT-WAIST-RETAINING BELT.—E. J. MONTIGNY, New York, N. Y. One purpose of the invention is to provide a belt especially designed to be worn in engagement with the outside of a shirtwaist, that is, between the waist line of the skirt and the shirtwaist, which belt will effectually hold the shirtwaist down, and will not at any point in its length have a tendency to work upward so as to appear above the skirt waist-band.

Electrical Devices.

CONNECTING DEVICE.—G. A. SCHNAUFER and H. G. SMOCK, Denver, Col. In this patent the invention has reference to electrical connections, and more particularly to a connecting device for telephone, telegraph and electric lighting wires, the purpose being to render it easy to tap on or take off wires leading from the ordinary service lines.

TIME-CONTROLLED ELECTRIC SWITCH.—J. W. WOOD, Mobile, Ala. The invention relates to electric switches, the more particular object being to provide such switches with means whereby a timepiece may control the movements of the switch. Further, it relates to the provision of connections from the timepiece to the switch, for enabling the timepiece to be set so as to cause the movement of the switch to take place at any desired moment.

Of General Interest.

CALENDAR.—J. FERRERES, Habana, Cuba. The invention relates more particularly to calendars in which the same numerals and designations of the days of the week may be employed for each month in the year by adjusting their relative positions, and also may be used for any number of years, thus rendering the calendar good for an indefinite period.

FIRE-EXTINGUISHER.—S. Q. STANLEY, Casper, Wyoming. The invention resides in a receptacle adapted to contain extinguishing material in granular or powdered condition, an explosive cartridge arranged within the vessel, and fuses extending from the cartridge to the exterior of the vessel, the fuses being designed, when ignited, to effect explosion of cartridge, or igniter, and cause violent breakage of vessel, and scattering the powder over considerable area, and smothering the flames.

NON-REFILLABLE BOTTLE.—A. WICKE, New York, N. Y. The invention pertains to improvements in bottles and more particularly to means whereby the bottle, after having once been filled and emptied, cannot be refilled. It is designed for use in connection with an ordinary form of bottle and readily applied thereto, thus rendering the device capable of more universal use, and serving to provide a simple and inexpensive construction.

BOX.—F. E. WARD, New York, N. Y. The underlying purpose in this case is to provide a box in which the opening movement will be limited, preventing the parts from complete separation, and which may be conveniently hung on the wall in open position so that the matches may be freely taken from the box. It may be constructed of paper, cardboard, wood veneer, or the like.

CRUTCH.—A. D. WICK, Topeka, Kan. The purpose of the inventor is to produce a crutch the length of which can be adjusted to suit persons of different height. The special object has been to provide a construction which will accomplish this object without the use of springs or similar contrivances likely to get out of order.

CAPTIVE BALLOON.—H. A. HERVÉ, 1 Rue Hautefeuille, Paris, France. The object of this inventor is to enable observations for military or scientific purposes to be made under a greater wind pressure or at a greater altitude for a given pressure of wind, while insuring greater stability of the car with a smaller tractive effort than in known systems of captive balloons under the combined conditions of strength and lightness necessary in such structures.

BREAD-SLICER.—H. FRANK, Lickingville, Pa. The slicer is especially useful for use in hotels, restaurants, and similar places where bread is sliced in large quantities. The inventor's aim is to produce a device which can be rapidly operated to slice the bread, the construction being such as to enable the thickness of the slices to be adjusted at will.

MINE-DOOR.—O. N. EARTHOM and T. G. GALLAHER, Adena, Ohio. The object of the improvement is to provide an efficient mine door for regulating the ventilation in mines and other similar workings, which is operable by a car for ore, coal, and the like, and which is so constructed that it opens and closes transversely of the mine passageway, thereby requiring less room for its operating than a swinging door.

BUTTER MEASURE AND CUTTER.—D. F. CURTIN, St. Louis, Mo. The invention pertains to improvements in devices for weighing and computing quantities of butter, its object being to produce a device which shall be simple and efficient, and one in which any given quantity of butter at a given price will be pressed into shape and cut from the mass of butter.

Hardware.

RAZOR-BLADE HOLDER.—S. FRAZIER, Bristol, Va. This is a device for holding blades when they are being stropped. The inventor's intention is to produce a device which is simple in construction and which can be readily operated to seize or release the razor blade and which will hold the blade very securely for stropping.

IMPLEMENT FOR EXTRACTING SPIKES AND BOLTS.—S. F. EUBANK, Columbia, Ky. This nail and bolt extractor comprises a handle lever, jaws pivoted on the handle lever, a supplementary lever, a bolt passing transversely through the jaws near gripping edges thereon, a cam and ratchet wheel device operable by the supplementary lever for compressing the jaws, and a spring pressed by the jaws when the jaws are compressed and expanding them when they are released.

Heating and Lighting.

SECTIONAL STAND.—F. G. GRIMLER, Buffalo, N. Y. The invention is an improvement in stands of a flexible nature, more especially designed as a support for an incandescent lamp, but usable for carrying various other forms of lamps. The object is to provide a construction composed of a series of units movable one upon the other and forced together by resilient means which is adjustable, whereby the frictional engagement of the several units may be varied.

Railways and Their Accessories.

BRAKE MECHANISM FOR INCLINED RAILWAYS.—S. E. JACKMAN, New York, N. Y. The invention refers to brake mechanisms for inclined railways, such as shown and described in Letters Patent of the U. S., formerly granted to Mr. Jackman. His aim is to provide a mechanism, arranged to control the car on the home stretch, independently of the occupants of the car, with a view of checking the speed of the car and bringing it finally to a stop at the station. Mr. Jackman has also invented another brake mechanism for inclined railways and it refers to such as shown and described in Letters Patent of the U. S., formerly granted to him. The object of the present improvement is to provide a brake mechanism, arranged in the track and under the control of an operator stationed near it, to check the car speed wholly independent of the occupants, and to bring the car to a stop at the home station.

STATION-INDICATOR AND ADVERTISER.—A. P. BONNAFFONS, New Orleans, La. This invention is intended particularly for use in street railway service, but is useful in other connections. One object is to provide an indicator which will be automatically operated as the car passes along the track, and exhibit to the view of the passengers the name of the next station or street crossing.

CAR-DOOR.—R. HALL, Kenora, Ontario, Canada. This car-door is to be used auxiliary to the usual door of box cars, and is especially designed to facilitate the unloading of granular materials such as grain, coal, sand, and the like. Among other objects of the inventor is to provide a door that will safely retain the material while loading and when in transit; also one which can be readily and easily opened so that the material will freely run out to the angle of repose when it is desired to discharge the loaded car.

SIGNAL SYSTEM.—B. F. MERKEL, Salida, Col. This improvement has reference to signal systems, the more particular object being to provide a system for displaying a target directly over a track where it may be more readily seen by the engineer, and for housing this target as well as rendering it invisible when not in use.

SAFETY DEVICE FOR INCLINED RAILWAYS.—S. E. JACKMAN, New York, N. Y. The invention relates to devices such as shown and described in Letters Patent of the U. S., formerly granted to Mr. Jackman. The aim of the present invention is to provide a device, such as used in pleasure resorts, exhibition grounds, and the like, and arranged to prevent accidental return or downward movement of the car while traveling up the inclined track portion of the track in cases of accident to the propelling mechanism or other cause.

Pertaining to Vehicles.

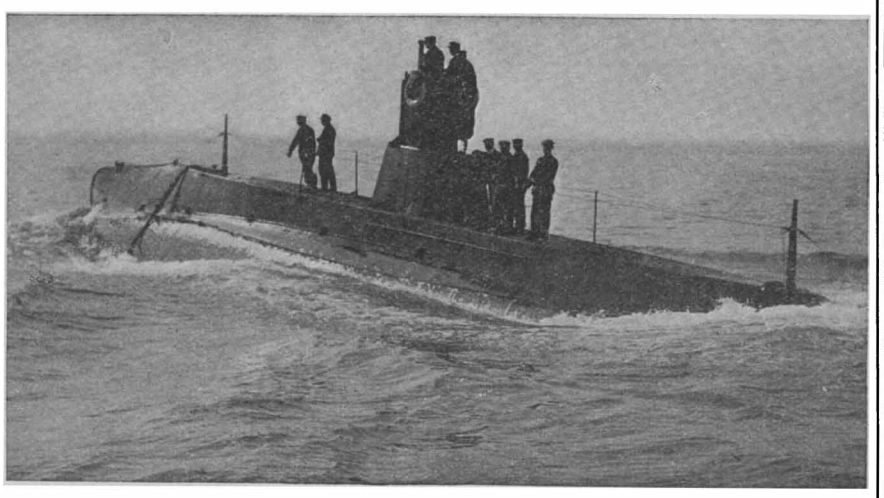
FLEXIBLE WHEEL FOR MOTOR AND OTHER VEHICLES.—H. F. NICHOLS, Grenfell Street, Adelaide, South Australia, Australia. The object of this invention is to provide a resilient wheel which shall have the advantages of the pneumatic tire without its disadvantages such as the liability to puncture. The invention relates to wheels of the kind constructed with an outer flexible rim or tire and an inner rigid rim, with a series of springs arranged between and connecting them.

BOLSTER-PLATE FOR VEHICLES.—I. BROADHEAD, East Branch, N. Y. The purpose of this improvement is to provide a construction of bolster plates for the running gear of wagons, particularly lumber wagons, whereby the bolster is held rigid and the use of the king bolt is dispensed with, which latter article greatly impairs the strength of the axle, and whereby also the bolster cannot be accidentally separated from the sand bar.

POLE AND SHAFT FOR ROAD-VEHICLES.—J. A. MONTGOMERY, Walton, N. Y. This simple mechanism, properly applied on the thills of two-wheeled road carts and carriages, insures entire absence of their objectionable horse motion, retains their thills permanently in their original shape, and the inventor feels justified in claiming that it is the last part of the vehicle to require repair or wear out.

NOTE.—Copies of any of these patents will be furnished by Munn & Co. for ten cents each. Please state the name of the patentee, title of the invention, and date of this paper.

The "Octopus" Type



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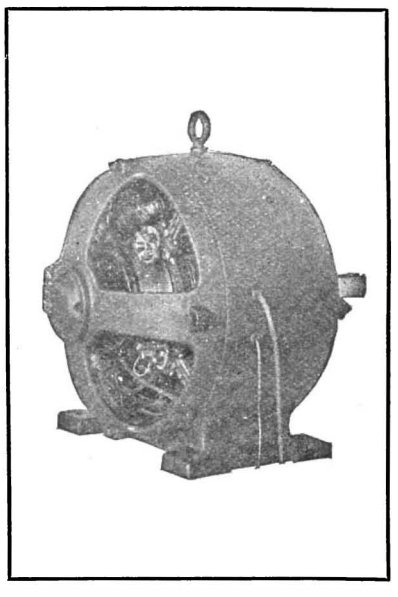

Electro-Dynamic Co.

BAYONNE, N. J.

PHILADELPHIA, PA.
Arcade Building

PITTSBURGH, PA.
200 Ninth Street

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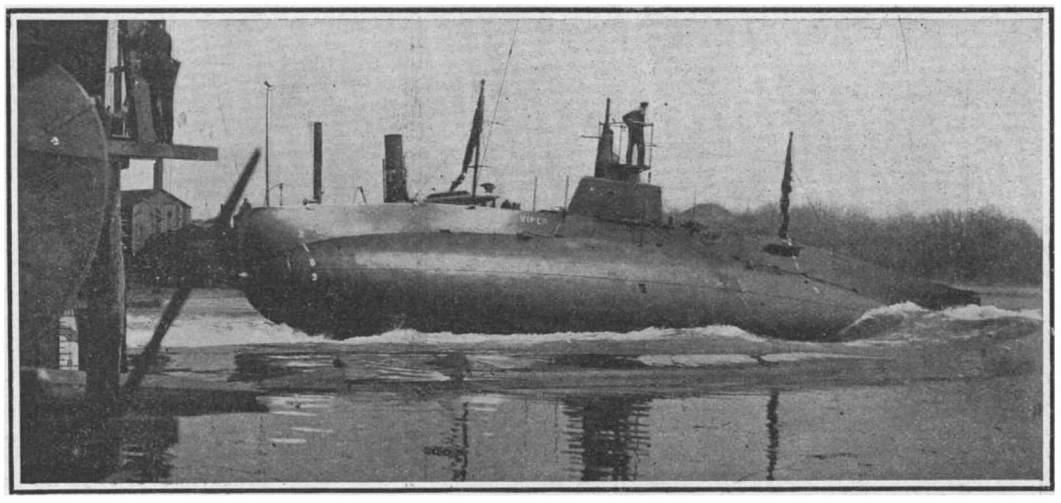
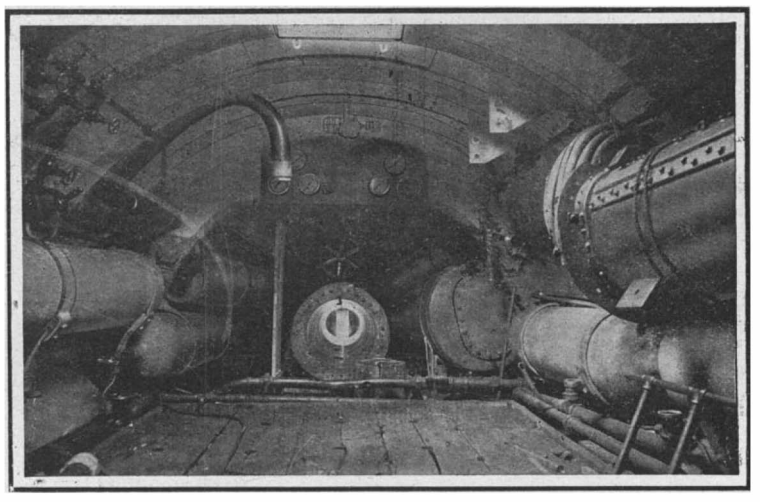
THE DEVELOPMENT OF OUR SUBMARINE FLEET.

The fleet of twelve submarines of the United States navy has been created entirely since the war, with one exception, the "Holland" being constructed several years prior to that time. In the following year seven additional submarines, known as the "Adder," "Grampus," "Moccasin," "Pike," "Porpoise," "Shark," and "Plunger," were authorized and subsequently built at Elizabethport, N. J. The "Holland," which was purchased for purposes of experimentation and practice, is 54 feet in length over all, of 10 feet 3 inches beam, and of 74 tons displacement when submerged. She is driven on the surface by gasoline engines of 45 horse-power, and when submerged by an electric motor of 50 horse-power. She carries one torpedo tube. The other seven submarines are enlarged and improved "Hollands," 63 feet 10 inches in length, 11 feet 10½ inches in diameter, and of 122½ tons displacement submerged. The motive power consists of a 160-horse-power gasoline engine, which drives them at about 8½ knots on the surface, and a 70-horse-power electric motor which gives them, when submerged, a speed of about 7½ knots. In 1904 Congress authorized the construction of four additional submarines of much greater size and efficiency. Three of these, known as the "Cuttlefish," "Tarantula," and "Viper," are of one type, the "Octopus" being larger than the others. Although they follow broadly the general design of the earlier boats, they are much more powerful, have a wider radius of action, are of greater structural strength, of higher speed, and possess superior maneuvering qualities. The three submarines of the "Cuttlefish" type are about 80 feet long over all, 12½ feet in diameter, and displace 175 tons. On the surface they are driven by gasoline engines at a speed of 10 knots, and in the submerged condition the electric motors have driven them over the mile course at a speed of 9 knots. They are supplied with a submarine bell signal system for communication with the surface. They submerge by filling various ballast tanks distributed throughout the boat. The reserve of buoyancy when in diving trim is from 500 to 1,000 pounds. To navigate the boat submerged the propellers are started, and by means of the diving rudders, which are turned downward, the axis of the vessel is inclined by the bow from 5 to 10 degrees. To maintain submergence after reaching the desired depth the diving rudders are shifted and the boat is thus held at the required depth. The process of diving is as follows: Water is admitted to the ballast tanks until buoyancy is reduced to the desired degree, which is generally between 500 and 1,000 pounds. The propellers are started and the diving rudders put down, the vessel descending on a downward incline. To return to the surface the diving rudders are put up, the boat traveling to the surface on an upward incline.

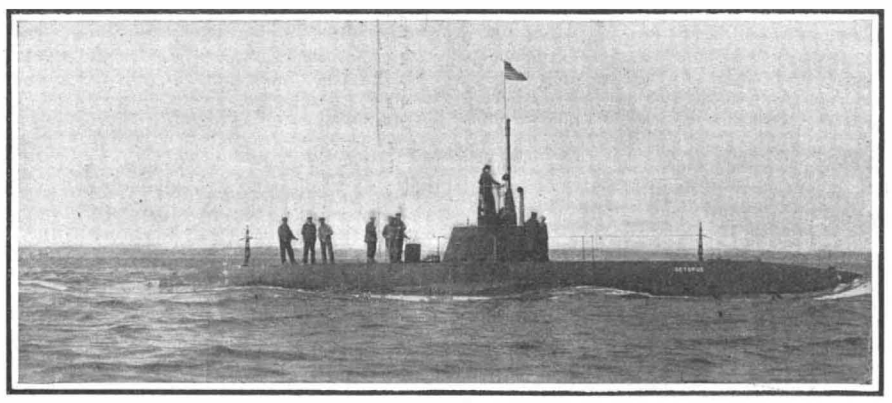
The trials of the "Octopus" lately carried out by a special trial board of the navy gave very gratifying results. In three runs over the mile course, using only her gasoline engines, she averaged a little over 11 knots, the first run being made at 11.6 knots. Running submerged and using only her electric motors, she made a speed of about 10 knots. In the submergence test, while going at full speed on the surface, she shifted her motive power from gasoline engines to electric motors, filled her ballast tanks, and dived to a depth of 20 feet in 4 minutes and 20 seconds. In the test of the automatic devices for blowing the ballast in order to allow the boat to come to the surface in case of accident, she rose from a depth of 40 feet in 43 seconds. In the twenty-four hours' submergence test in 30 feet of water, she carried down a crew of sixteen men, and came to the surface next day with the men in good condition. The "Octopus" has been tested as to strength and watertightness by actual submergence to a depth of 200 feet.



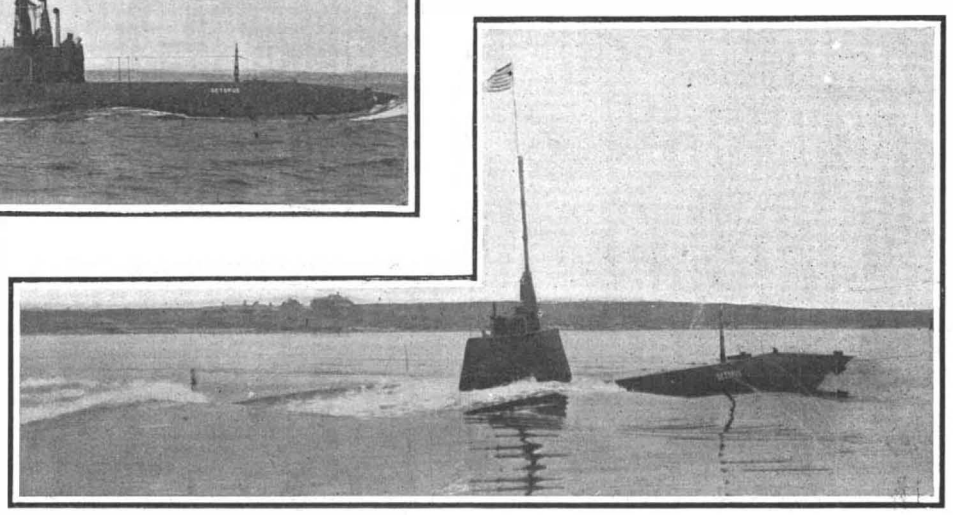
Launching a Submarine.



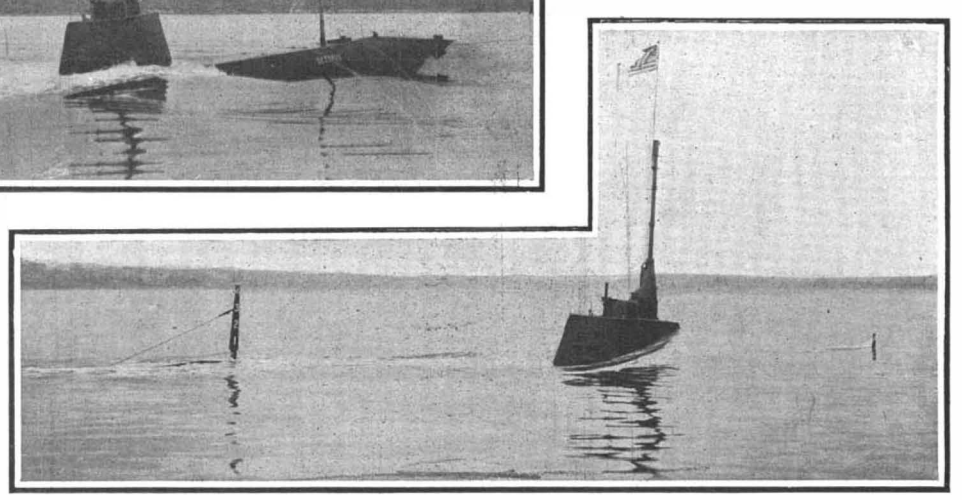
Interior of Submarine Looking Forward.



Running on the Surface.



Rising from a Dive.



The "Octopus" Diving.

SIMPLE EXPLANATION OF MODEL BASIN METHODS.

(*Continued from page 418.*)

ried on in open water, unless model basins in the future are built of much greater dimensions than those now existing. In the particular case we have been considering, the wetted surface of the ship was 38,230 feet. The coefficient of friction for a ship 500 feet long in salt water is from Tideman's tables 0.00904 and the 1.83 power of 20, the speed of the ship in knots, is 240.37. Hence, the frictional resistance in pounds is 38,230 x 0.00904 x 240.37 = 83,100. The total resistance at 20 knots is, then, 207,000 pounds.

As a rule, since the practical application of model basin results is in connection with power, we wish to calculate not resistance, but what is known as effective horse-power; that is to say, horse-power which would be absorbed by the resistance at the speed of the ship. In the case in hand, for instance, the resistance at 20 knots is 207,000 pounds. A speed of 20 knots is a speed of 2026.6 feet per minute. Hence, the resistance will absorb 419,500,000 foot-pounds per minute and the effective horse-power would be $\frac{419,500,000}{33,000}$, or 12,700 in round numbers.

The process described above may seem somewhat complicated in the telling, but by the use of forms and tables developed by experience it is rendered comparatively short and simple.

The law of comparison as applied to ships is a special case of the general mechanical law of similitude connecting the operation of any kind of model with the corresponding full-sized object. It is applicable to machines, such as steam engines, ventilating fans, screw propellers, and others. It is necessary, however, that certain conditions be satisfied, the essential conditions as regards the motion of liquids being that the motions should be similar and that the pressures at corresponding points should be in the same ratio as the linear ratio between model and ship. This condition is fulfilled as regards the waves created by models and ships, careful observations and comparisons having shown that they correspond very closely, indeed.

Fig. 2 shows, for instance, the wave line, forward and aft, as measured against the side of a large United States battleship on trial and the corresponding wave line deduced from model experiments in the United States model basin. The coincidence is seen to be close, being practically exact as regards length of wave and within the limits of error of observation as regards height. On the actual ship the extreme height of the bow wave forward is some 16 or 17 feet above still water, while the height of the bow wave of the model at corresponding speed was only about 8 or 9 inches. There generally seems to be a slight tendency for the bow wave forward to be a shade lower than would be indicated from the model experiments, while the wave as measured aft is a little higher; but generally there is so much broken water aft on the full-sized ship that the wave is measured high.

In the case of the waves the uniform pressure of the atmosphere has no effect upon the result. Practically the same wave would be created if model or ship were running in a vacuum. When it comes to eddy resistance, however, the case is different, particularly eddy resistance around submerged objects, such as struts. Here the pressure of the atmosphere results in the fluid pressure at any given point of the model being much greater than it should be to correspond with the fluid pressure at the corresponding point of a full-sized ship. This excess pressure may prevent the formation of eddies in the case of the model which would appear if the fluid pressures were reduced to correspond to the pressures around the full-sized ship. This would not be the case behind a square stern-post, for instance, because the area in rear of this would be full of eddies for either model or ship. But we might have cases where eddying around

(*Continued on page 433.*)

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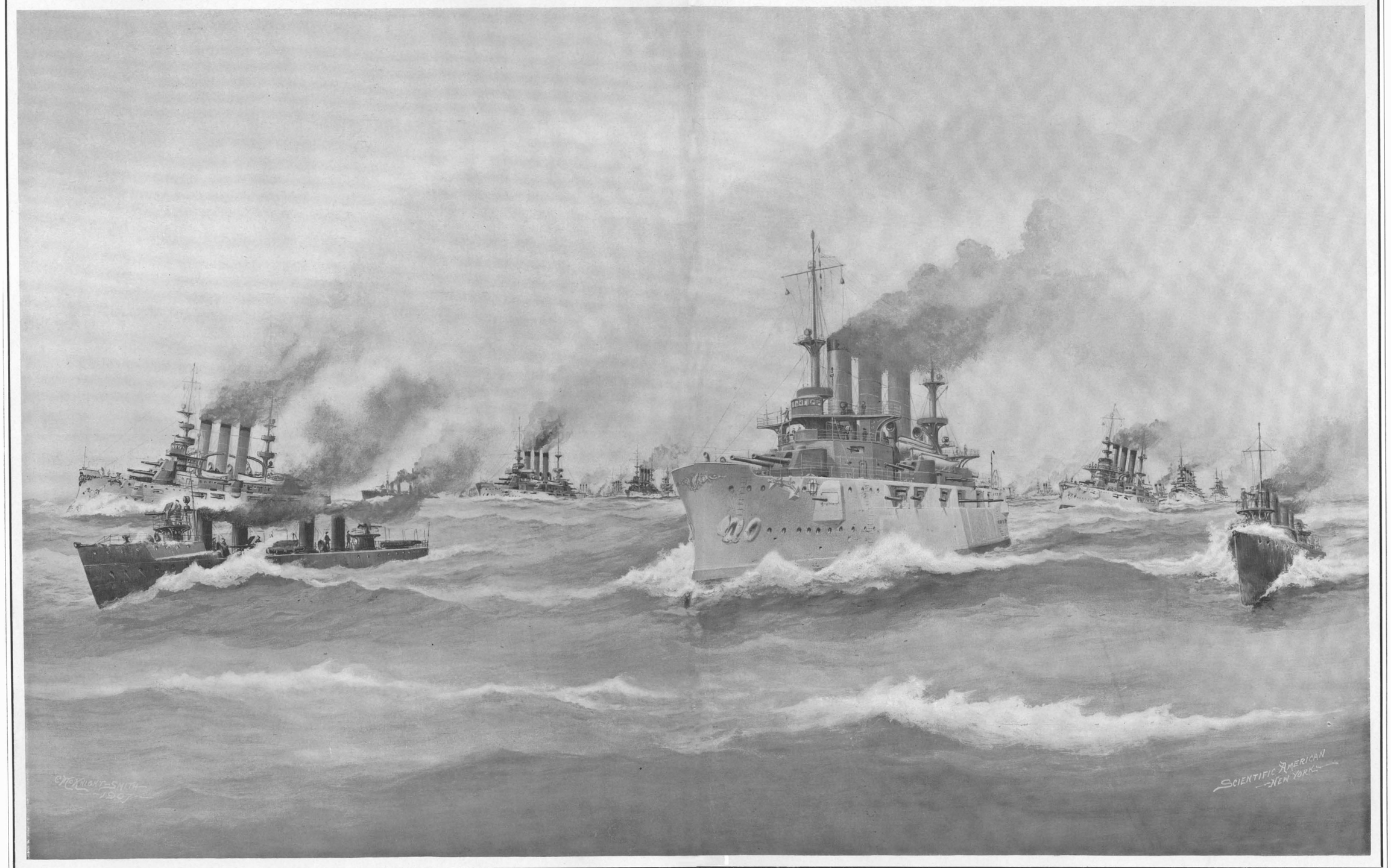

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16,094 tons—Speed 19 knots.
Torpedo-boat Destroyer
"STEWART"
420 tons—Speed 29 knots.

Torpedo-boat Destroyer
"HOPKINS"
408 tons—Speed 29 knots.

"VIRGINIA"
16,094 tons—Speed 19 knots.
"MISSOURI"
13,500 tons—Speed 18 knots.

"NEW JERSEY"
16,094 tons—Speed 19 knots.
"RHODE ISLAND"
16,094 tons—Speed 19 knots

"OHIO"
13,500 tons—Speed 18 knots.
Torpedo-boat Destroyer
"TRUXTON"
433 tons—Speed 30 knots.

"MINNESOTA"
17,650 tons—Speed 18 knots.
"MAINE"
13,500 tons—Speed 18 knots.

Torpedo-boat Destroyer
"LAWRENCE"
400 tons—Speed 30 knots.

"CONNECTICUT"
Flagship
17,770 tons—Speed 18 knots.

"KEARSARGE"
12,320 tons—Speed 16 knots.
"ILLINOIS"
12,150 tons—Speed 16 knots.
Torpedo-boat Destroyer
"WHIPPLE"
433 tons—Speed 30 knots.

"LOUISIANA"
17,770 tons—Speed 18 knots.

"KANSAS"
17,650 tons—Speed 18 knots.
"ALABAMA"
12,150 tons—Speed 16 knots.
"KENTUCKY"
12,320 tons—Speed 16 knots.

Torpedo-boat Destroyer
"HULL"
408 tons—Speed 29 knots.
"VERMONT"
17,650 tons—Speed 18 knots.

THE TRUE SIGNIFICANCE OF THE PACIFIC CRUISE.—THE DEPARTURE OF THE BATTLESHIP SQUADRON.

SEE ARTICLE BY CAPTAIN A. T. MAHAN, PAGE 407.

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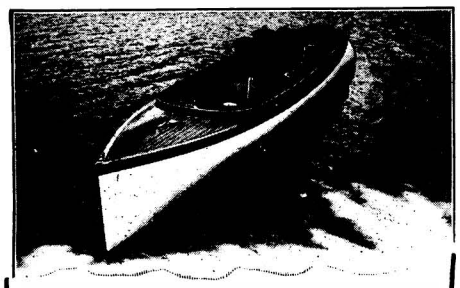
Fay & Bowen Motor Boats



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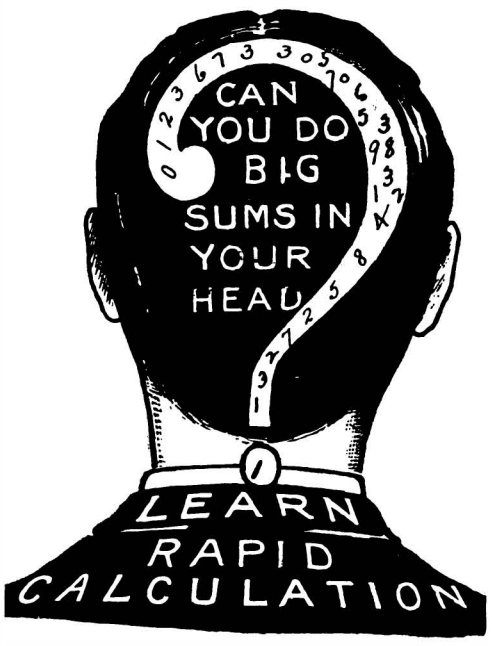

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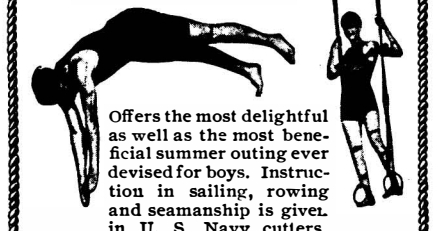

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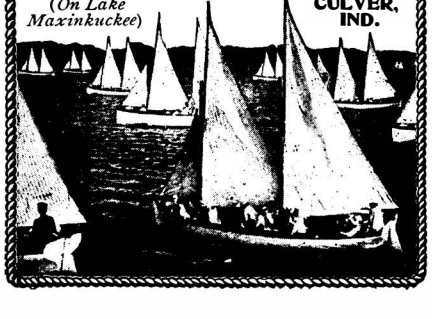

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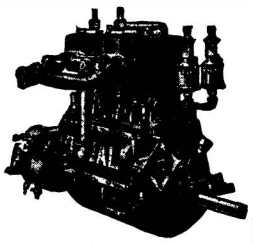

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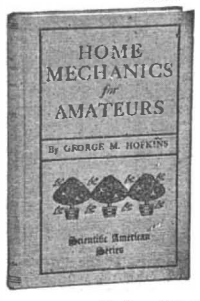

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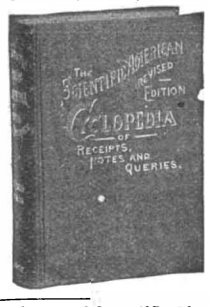

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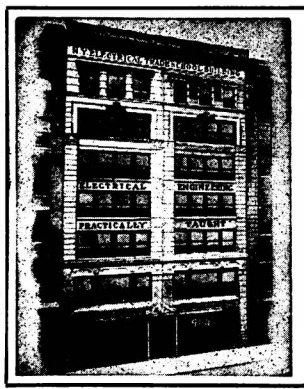

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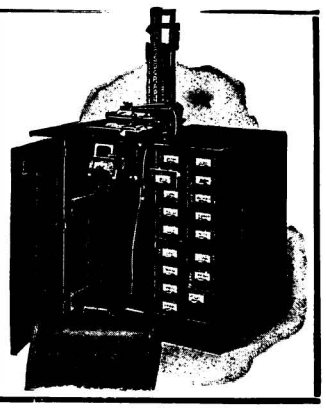

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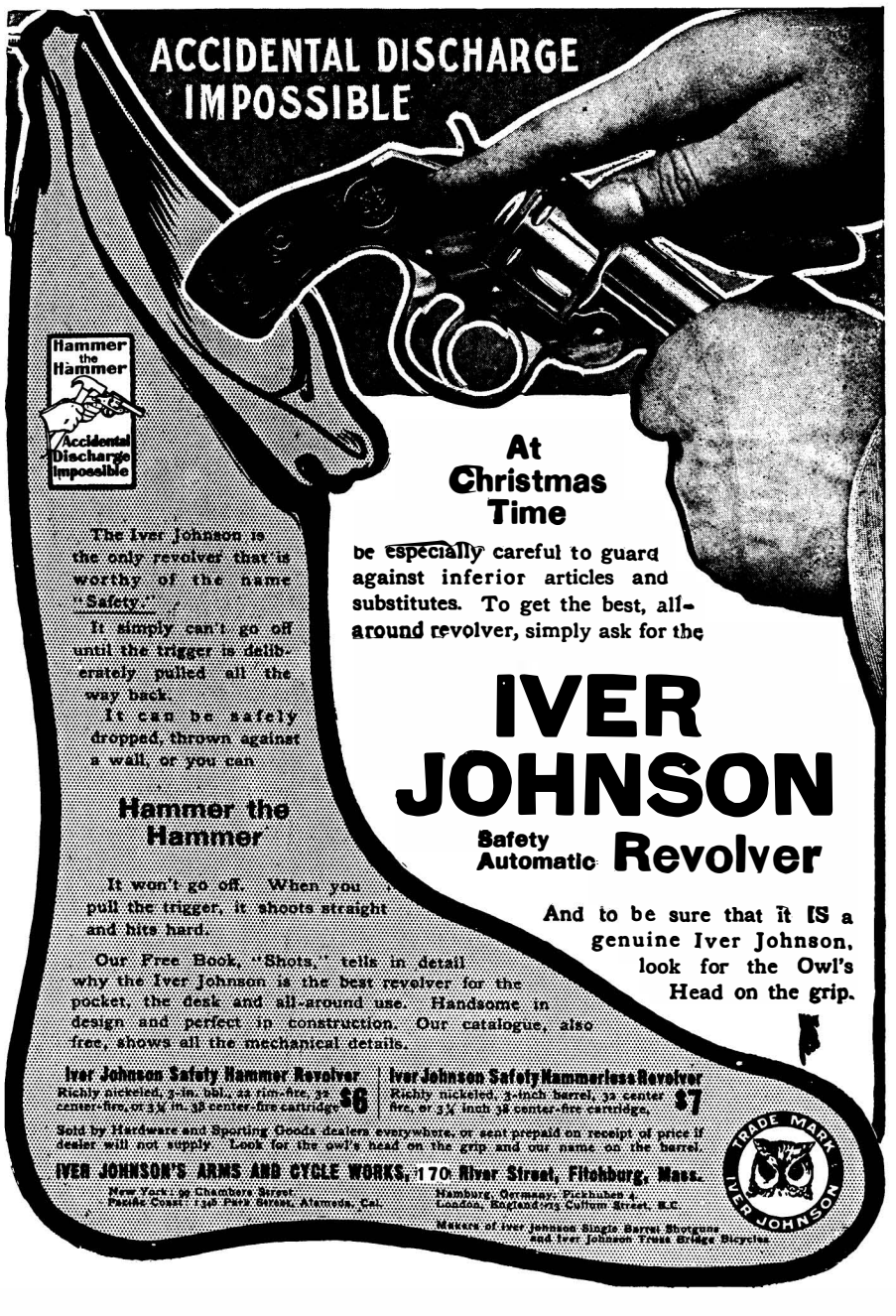
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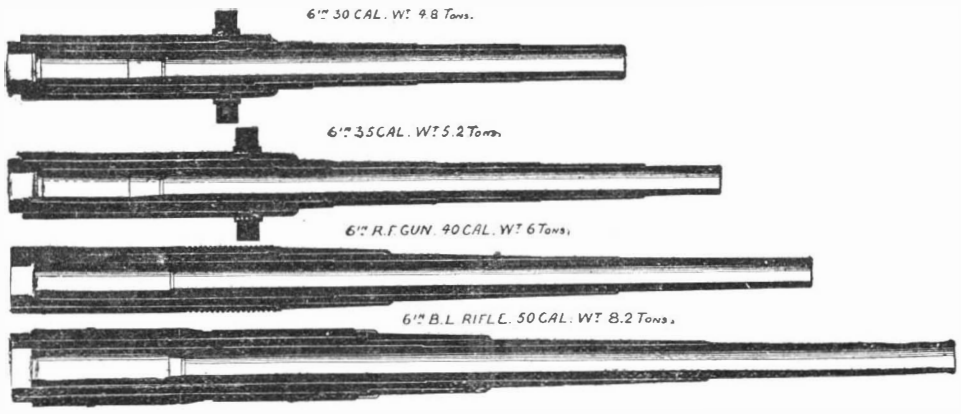
GUNS AND ARMOR

If the primary function of a warship is to give and take hard knocks, it is not stretching the point too far to say that the greatest development in our navy during the past ten years has been in the matter of guns and armor. In 1897 our navy was in a parlous state in respect of its powder; and, although the guns were serviceable, they were sadly behind the long-range, flat-trajectory, pieces of some of the foreign powers. When war was declared, our ships, with few exceptions, were armed with guns of low velocity and energy, and their magazines were filled with the already out-of-date brown powder. At the battle of Santiago our ships were at times absolutely enveloped in dense billows of the smoke of their own guns; and, in spite of the comparatively close ranges at which the running fight was carried on, the number of hits, as determined by a careful subsequent investigation by our naval officers, was only two out of every hundred shots fired. Since the close of the war, our Naval Bureau of Ordnance has done most creditable work as its share of the general improvement of our navy. It has developed a powder which is giving high velocities, with a relatively small amount of erosion. The bureau early became satisfied that, if erosion was to be kept within reasonable bounds, it was necessary to eliminate the powerful but erosive nitroglycerine, and develop, if possible, an all-nitrocellulose powder. This has been done; and as far as our information goes, there is less trouble with erosion in our naval guns than in those of the foreign powers. The only drawback, and it is one of some consequence, is that a powder chamber considerably larger than that necessary for high-nitroglycerine powder is necessary; and there is a consequent increase in the size of the charge, and a call for greater stowage space in the ammunition rooms. The greater velocity and power of the guns with which our latest ships are armed are due, mainly, to the use of smokeless, slow-burning powder. The advantage of this powder lies in the fact that its slow rate of burning enables it to give off fresh volumes of gas during the whole of the time that the projectile is traveling down the bore. The earliest black powders (and in a less degree the brown powders) were ignited almost instantaneously, and their whole mass converted into a volume of gas at high pressure, whose pressure fell rapidly during the travel of the shot, until, at the time the projectile left the muzzle, it amounted to not more than about a ton and a half to the square inch. In the new guns, the continual formation of gas during the travel of the projectile serves to prevent this rapid fall of pressure so effectually, that, if the projectile is started under a pressure of say 18 tons to the square inch, at the instant of leaving the muzzle it is still under a pressure of as high as 6 to 8 tons to the square inch. The result is seen in the fact that, whereas the velocity of the guns used in the Spanish war was only about 2,000 to 2,100 feet per second, the velocity in our present guns is from 2,700 to 2,800 feet per second. This increased velocity has a double advantage; for since the energy increases as the *square* of the velocity, there is necessarily a great increase in the striking energy at all ranges; and, secondly, the higher velocity means a lower trajectory or curve of flight, a wider danger space, and far greater likelihood of hitting the mark. The accompanying table embodies the latest types of guns, with which the majority of the ships of the Pacific fleet are armed; and a comparison of these with the corresponding pieces mounted during the war shows what a great advance has been made.

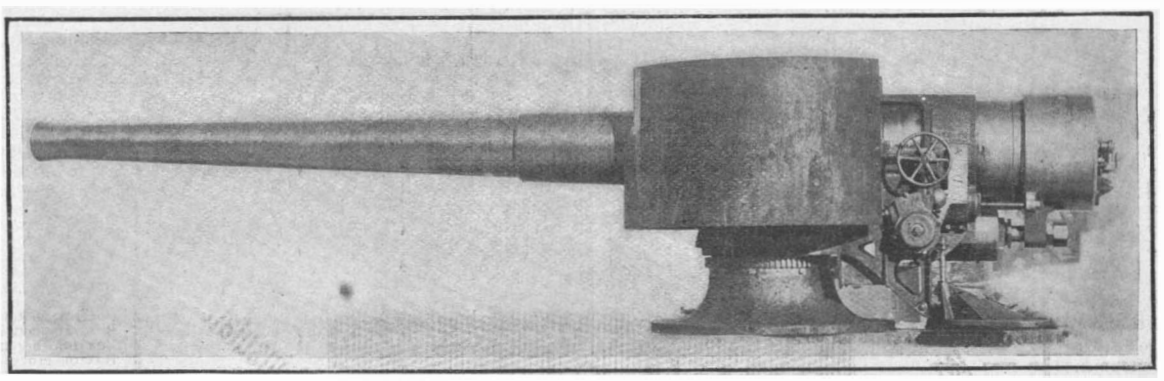
That the remarkable increase in the fighting power of the ships of the Pacific fleet is due to the improved guns and powder, is well shown in the accompanying tabular comparison of the total energy of fire in five minutes of the battleship "Oregon" of Sampson's fleet at Santiago and the battleship "Rhode Island" of the Pacific fleet. The total energy of all guns firing at their maximum rate of speed, with carefully aimed shots, was for the "Oregon" 819,456 foot-tons; whereas the total energy of all guns during the same time on the "Rhode Island" would be 3,927,172. The increase in efficiency of the modern gun is largely due, moreover, to the greatly accelerated rate of fire; and this has been rendered possible by improvements in the mounting of the gun and in the breech mechanism and loading arrangements. One of the most important improvements conducing to rapid fire is the means adopted for enabling the gunner to hold the gun steadily upon the target. In early guns the sights were mounted upon the gun itself, and moved with the gun at every recoil. Now, the sights are mounted upon a sleeve which carries the trunnions, and in this sleeve the gun recoils. The man who traverses and elevates the gun stands on a platform, which is supported from this same sleeve; so that the gunner and his sights, which are of the telescopic kind, are not disturbed by the discharge of the gun, and he is enabled to keep the cross wires in the eye-piece of the telescopic sight upon the target with great accuracy. Other important improvements are found in the methods of bringing the ammunition up from the hold and loading and firing the guns. The 7-inch guns and all calibers below open the breech with a horizontal lever, one single sweep of which unlocks the threads of the breech plug, withdraws the plug, and swings it clear of the breech. The 8-inch rifle and all calibers above this open the breech with a crank, the plug being too heavy for manipulation by the swinging lever. Undoubtedly the most interesting gun carried in Admiral Evans's fleet is the new 45-caliber piece, which weighs 53 tons and is 46 feet in length. It fires a projectile weighing 870 pounds with a charge of smokeless powder weighing 335 pounds. The projectile leaves the muzzle with a velocity of 2,700 feet per second, and a corresponding muzzle energy of 44,025 foot-tons; or sufficient to lift the "Lusitania" bodily out of the water.

A problem in connection with the designing of big guns which calls for very careful planning and workmanship is the control of the recoil. Newton's well-known law that action and reaction are equal and opposite comes into play when a shell is fired. At the instant that a 12-inch projectile is driven from the muzzle of the gun with an energy of over 44,000 foot-tons, the gun itself is driven in the opposite direction, backwardly, with exactly the same energy; and

(*Continued on page 424.*)

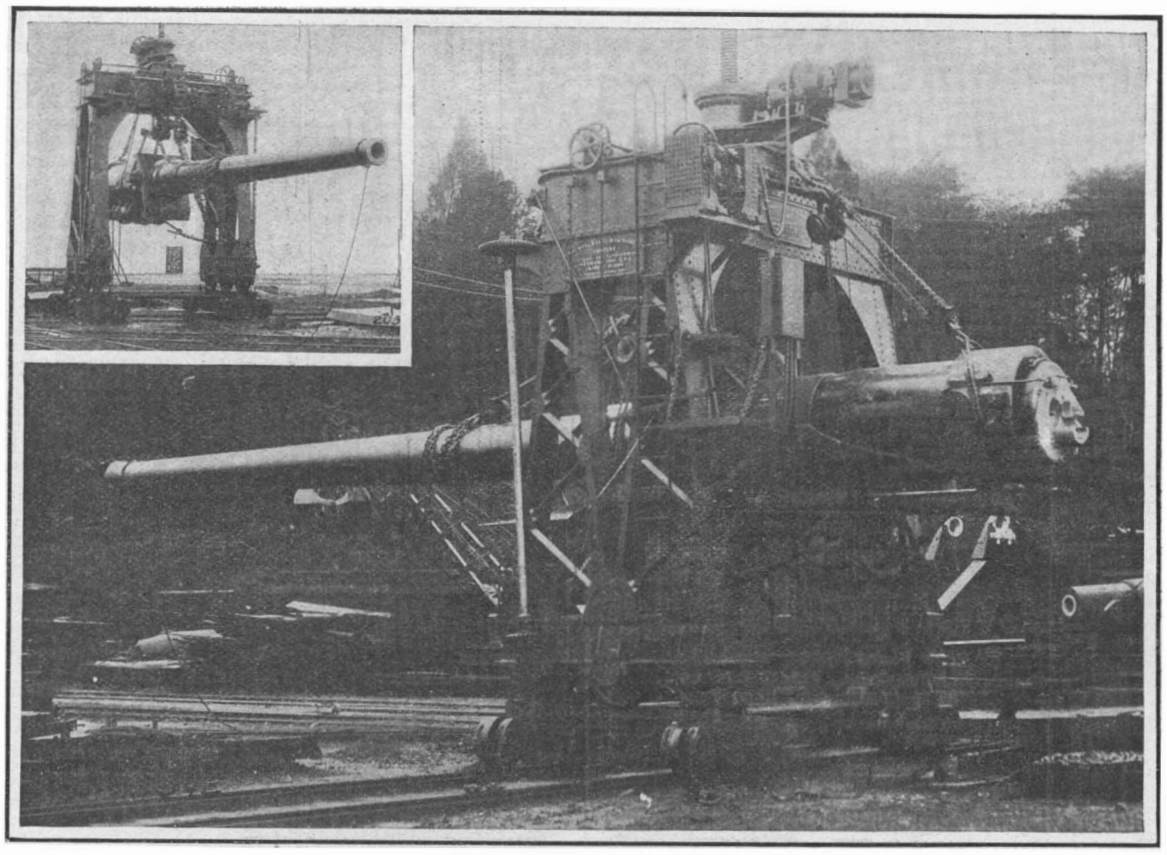


DEVELOPMENT OF 6-INCH GUN, 1883 TO 1901.



Weight of gun, 12.7 tons. **Length,** 27 feet. **Weight of powder charge,** 59 pounds. **Weight of projectile,** 165 pounds. **Muzzle velocity,** 2,700 feet per second. **Muzzle energy,** 8,349 foot-tons. **Perforation Krupp armor at 3,000 yards,** 6.4 inches.

SEVEN-INCH RAPID-FIRE GUN MOUNTED ON THE SIX BATTLESHIPS OF THE "CONNECTICUT" TYPE.



Weight of gun, 53 tons. **Length,** 46 feet. **Weight of powder charge,** 335 pounds. **Weight of projectile,** 870 pounds. **Muzzle velocity,** 2,700 feet per second. **Muzzle energy,** 44,025 foot-tons. **Perforation Krupp armor at 3,000 yards,** 16.3 inches.

THE NEW NAVY 12-INCH GUN ON TRANSFER CRANE AT PROVING GROUND.

Caliber of Gun.	Weight of Gun and Breech Mechanism, in Tons.	Length in Calibers.	Total Length in Inches	Approximate Charge of Smokeless Powder for Maximum Velocity, Pounds.	Weight of Projectile, Pounds.	Muzzle Velocity, Foot-Seconds.	Muzzle Energy, Foot-Tons.	Perforation at Muzzle, Krupp Armor		Remaining Velocity at 3,000 Yards	Perforation at 3,000 Yards, Krupp Armor.	
								Projectile, Capped.	Projectile, Uncapped.		Projectile, Capped.	Projectile, Uncapped.
3-inch, Mark V	1 0	50	159.35	4	13	2,700	658	3 2	2 8	1,230	1 1	1 0
4-inch, Mark VIII.	2 9	50	206.53	12	33	2,800	1,796	5.1	4 5	1,627	2 5	2 2
5-inch, Mark VI	4.8	50	255.65	20	60	2,700	3,036	6 3	5.5	1 692	3.4	2 9
6-inch, Mark VIII.	8 6	49	300.20	38	105	2,800	5,714	8 5	7.4	1,923	5 1	4.5
7-inch, Mark II.....	12.7	45	323.00	59	165	2,700	8,349	9 9	8 6	1,948	6 4	5.5
8-inch, Mark VI	18.7	45	369.00	100	260	2,750	13,647	12.5	10 9	2, 06	8.7	7.6
10-inch, Mark III.....	34 6	40	413.00	205	510	2,700	25,805	16.5	14 3	2,184	12.4	10 8
12-inch, Mark V..	52 9	45	553 00	335	870	2,700	44,025	20.8	18.1	2.259	16 3	14 2
13-inch, Mark II...	63.2	35	479.10	180	1,130	2,000	31,372	15 8	13.7	1,679	12 5	10.9

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Notes and Queries.

HINTS TO CORRESPONDENTS.

Names and Address must accompany all letters or no attention will be paid thereto. This is for our information and not for publication.

References to former articles or answers should give date of paper and page or number of question.

Inquiries not answered in reasonable time should be repeated; correspondents will bear in mind that some answers require not a little research, and, though we endeavor to reply to all either by letter or in this department, each must take his turn.

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Minerals sent for examination should be distinctly marked or labeled.

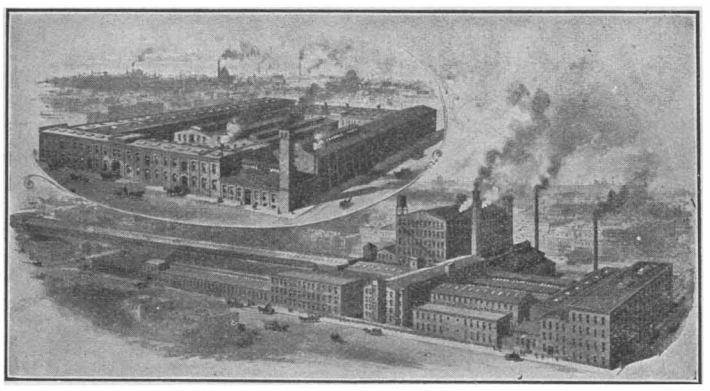
(10637) E. H. S. asks: Kindly advise me if you have a SUPPLEMENT that treats of the different kinds of molecular vibrations known to science. What I mean is this: I have been told that there are known 84 octaves of vibrations; the octave of heat above light, then light, next the photographic spectrum, and next the X-ray. Now, what I want to know is in what order do they come, and the name of each. A. There may be 84 octaves of vibrations. Of that we do not know. Even if there be, not all of the octaves are occupied. The lowest number of vibrations in sound is 16 per second. The ability of the ear to hear ends at about 40,000 vibrations per second. Heat vibrations can be distinguished for some distance below those of light, not above light, as you state. Above the vibrations of light come what are termed ultra-violet vibrations for several octaves. What may be beyond these we cannot certainly say. X-rays are not vibrations in the usual sense of the term. You would be interested in this connection in Duncan's "New Knowledge," price $2, and in Whetham's "Recent Development of Physical Science," price $2. We shall be pleased to receive your order for one or both of these or any other books.

(10638) W. J. H. asks: 1. When the ship crosses the line of the equator, does the needle in the mariner's compass deflect and point to the south pole? A. A magnetic needle has two ends: one end is directed toward the north, and the other toward the south pole of the earth. All over the world civilized people use the north end of the compass needle to steer by; the Chinese use the south end. There is no change whatever in the magnetism of a needle upon crossing the equator, nor in its use as a guide to a ship or traveler. It is wholly a matter of usage by which end one shall steer. 2. Is there any difference in the distance that a cannon will send a ball on either the land or the sea? A. Water and land alike have no effect upon the distance a cannon can throw a shot. The pressure of the gas in the gun alone determines the distance the ball will go.

(10639) A. H. G. asks: 1. In the case of electrolysis of water system by overhead trolley car system, is the eating away of pipes where the current enters or leaves the pipe? A. The electrolysis of water pipes and other metal by the return current of the trolley lines takes place where the current leaves the pipes or metals. 2. In modern practice, is it sufficient to have electric welded joints or rails, or should a return wire be provided: if so, should it be overhead or underground? A. If the rails are properly welded, no better provision for the return of the current under ground can be made. No wire is required.

(10640) J. V. G. H. writes: When gathering some wild flowers this morning I found (among an abundance of our common red or lilac thistle) a thistle with pure white blossoms. Will you kindly inform me if this is a common occurrence? Also about the possible explanation for this loss of color, and whether they continue white in coming years, and even would originate a new species? A. The common thistle occasionally has white flowers. We do not know whether this peculiarity could be transmitted by the seeds or not. One would hardly care to propagate thistles even to determine so interesting a question. It is quite common in many plants that white flowers appear in place of those of the usual color. It is also true of animals. This is not considered as the origination of a new species. This variation in the thistle is mentioned in the botanies.

(10641) H. W. J. writes: 1. To what degree of heat has wire glass been tested without yielding in any way? 2. To what degree has it been heated and then played upon by a fire hose without yielding? I have had some very high figures given and would like correct information. A. The claims on behalf of wire glass, as we understand them, are not so much that it does not "yield" (in the sense of cracking) under high temperature whether followed by a stream of cold water or not, but that it remains in place after being cracked, preventing sudden drafts accelerating a fire. We have no conclusive figures covering the tests you describe, but are endeavoring to obtain them and hope to give them later.



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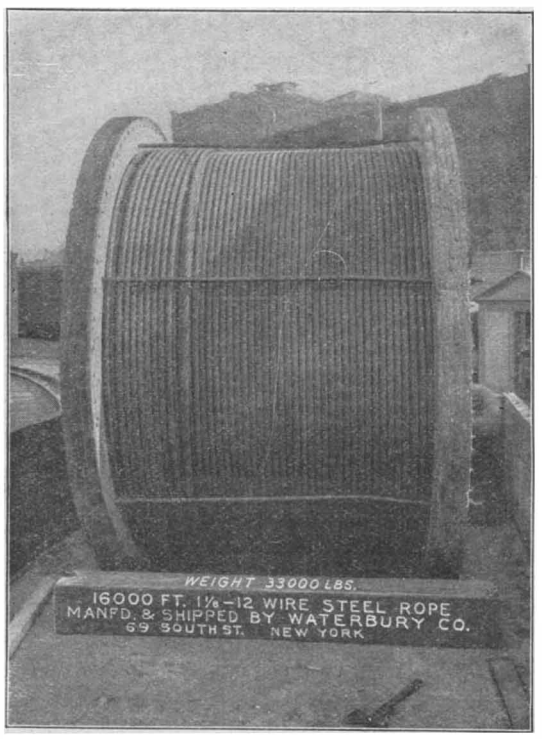

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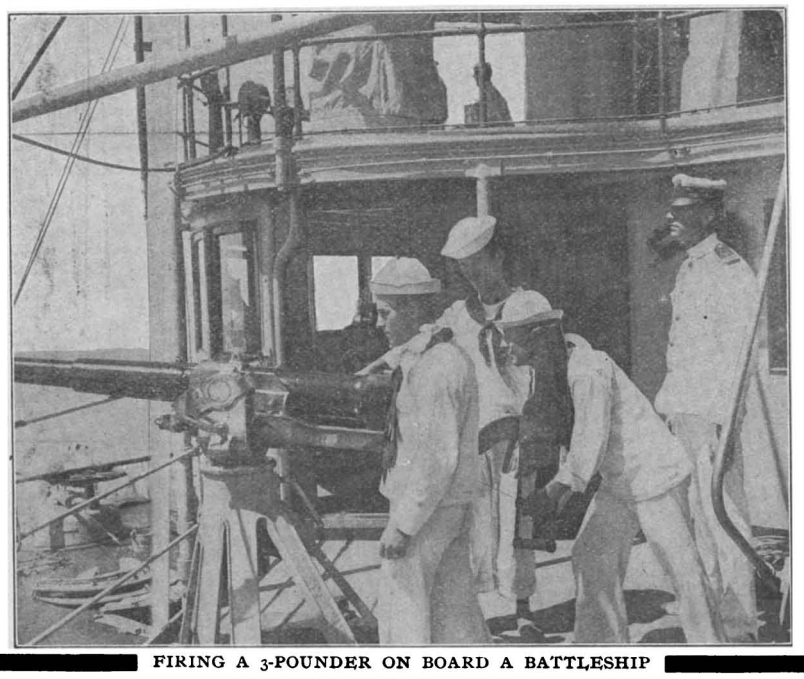

FIRING A 3-POUNDER ON BOARD A BATTLESHIP

INDEX OF INVENTIONS

For which Letters Patent of the United States were Issued for the Week Ending November 26, 1907.

AND EACH BEARING THAT DATE

[See note at end of list about copies of these patents.]

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GUNS AND ARMOR.

(*Continued from page 422.*)

if steps were not taken to control the 53-ton mass it would not stop moving until it had burst its way through the rear walls of the turret and wrought no end of havoc besides. It would be impossible to hold the gun absolutely rigid and prevent its recoil; for the shock would tear asunder any bolts or other fasteners which might be devised; or, if they should hold, it would wrench the fabric of the ship asunder. The recoil is rendered harmless by carefully-designed means for gradually absorbing the recoil; and this is done in the case of the 12-inch gun by hydraulic cylinders, attached to the sleeve or non-recoiling portion thereof. The sleeve and cylinders are shown very clearly in the accompanying photographs of a 12-inch gun at the Indian Head Proving Ground. The huge weapon is shown suspended in a 112-ton gantry crane and transfer car built by the Wellman, Seaver, Morgan Company, to whom we are indebted for our illustration. The action of the recoil cylinders of the gun is as follows: A massive yoke at the rear end of the gun serves as an attachment for the piston rods of the recoil cylinders, which are carried on the sleeve; and the recoil is checked by the escape, from the pressure side to the reverse side of the piston, of the liquid contained in the cylinders. The fluid escapes past the piston by means of grooves cut along the walls of the cylinders, which are wide enough to give a full opening at the beginning of the recoil, but gradually taper and contract in area, until the proper limit of recoil is reached, when the grooves come to a point and cut off any further flow of liquid. Inside each recoil cylinder is a series of spiral springs, which serve to keep the guns from moving, when the ship rolls or the gun is elevated. When recoil takes place, these springs are compressed, and they exert sufficient force to return the guns to the firing position as soon as recoil ceases. The same principle is followed in the guns of smaller caliber, such as the 8, 7, and 6-inch.

The illustration of the 12-inch gun should possess particular interest; for this piece will undoubtedly, for some years to come, constitute the sole armament for long-range fighting of our future battleships, and possibly even of our future cruisers. It must be admitted that, for a gun of 45 calibers length, the velocity of 2,700 feet per second is rather low, and not equal to that obtained by the 45-caliber 12-inch guns of the British and one or two other navies. Originally, these guns were planned for 2,800 feet per second; but it was found that the pressures toward the muzzle were rather greater than the guns could safely stand, and the pressures and velocities were, therefore, reduced. How long the 12-inch gun will continue to be our principal weapon it is hard to determine; but we rather expect to see a return to the 13-inch, with an increase of velocity to not less than 2,800 feet per second. Such a gun is more accurate, that is to say, more accurate shooting could be made with it at the long battle ranges which will obtain in future engagements. Moreover, its trajectory would be flatter, and its danger zone greater; it would maintain its velocity longer, and would reach the mark with 30 to 40 per cent greater hitting power.

COMPARISON OF TOTAL ENERGY OF GUNFIRE IN FIVE MINUTES OF BATTLESHIPS "OREGON" (1897) AND "RHODE ISLAND" (1907).*

Oregon in 1897.			Rhode Island in 1907.		
Guns.	Muzzle Energy, Ft.-Tons.	Muzzle Energy in Five Minutes' Firing, Ft.-Tons.	Guns.	Muzzle Energy. Ft.-Tons.	Muzzle Energy in Five Minutes' Firing, Ft-Tons.
4 13-inch	33,027	269,016	4 12-inch	44,025	726,412
8 8-inch	8,011	320,440	8 8-inch	13,647	1,091,760
4 6-inch	2,990	119,600	12 6-inch	5,714	1,714,200
20 6-pdrs	138	110,400	12 3-inch	658	394,800
Total energy all guns in five minutes.		819,456	Total energy all guns in five minutes....		3,927,172

* The enormous increase in energy is due largely to the greatly increased rapidity of fire, resulting from improved mechanism for handling and maneuvering the guns, and to the greater attention now paid to the training of the gunners. The above totals are calculated upon the number of carefully-aimed shots which each gun could deliver under battle conditions and not upon the extraordinary rapidity which has been obtained by crack gun crews in target practice.

On November 27 a train carrying some 200 invited passengers traveled from Manhattan Island to Borough Hall, Brooklyn, under the East River. The Battery tunnel has more than once been delayed in construction, but this journey gives hope that the delays are at an end and that a regular service will operate early in the new year. On the outward trip the distance of 1.6 miles was traversed slowly, to allow time for inspecting the tunnel, but a return journey was made in about five minutes.

TABLE OF VESSELS COMMISSIONED, COMPLETED, BUILDING OR AUTHORIZED SINCE THE SPANISH WAR.

BATTLESHIPS, MONITORS, AND ARMORED CRUISERS.

Name.	Type.	Displacement in Tons.	Speed in Knots.	Armor.		Armament.	
				Belt.	Gun Positions.	Main.	Secondary.
Kearsarge	Battleship.	11,540	16.8	16½ in.	17 in.—15 in.	4 13-in. B. L. R. 4 8-in. B. L. R. 14 5-in. R. F. G.	20 6-pounders. 8 1 " 6 small guns.
Kentucky	"	"	16.9	"	"	"	"
Alabama	"	11,565	17.1	"	15 in.—14 in.	4 13-in. B. L. R. 14 6-in. R. F. G.	16 6-pounders. 6 1 " 6 small guns.
Illinois	"	"	17.4	"	"	"	"
Wisconsin	"	"	17.2	"	"	"	"
Maine	"	12,300	18.0	11 in.	12 in.—12 in.	4 12-in. B. L. R. 16 6-in. R. F. G. 6 3-in. R. F. G.	8 6-pounders. 6 1 " 4 small guns.
Missouri	"	"	"	"	"	"	"
Ohio	"	"	"	"	"	"	"
Georgia	"	14,948	19.0	"	11 in.—10 in.	4 12-in. B. L. R. 8 8-in. B. L. R. 12 6-in. R. F. G. 12 3-in. R. F. G.	12 3-pounders. 8 1 " 10 small guns.
Nebraska	"	"	"	"	"	"	"
New Jersey	"	"	"	"	"	"	"
Rhode Island	"	"	"	"	"	"	"
Virginia	"	"	"	"	"	"	"
Connecticut	"	16,000	18.0	"	12 in.	4 12-in. B. L. R. 8 8-in. B. L. R. 12 7-in. R. F. G. 20 3-in. R. F. G.	12 3-pounders. 8 1 " 10 small guns.
Louisiana	"	"	"	"	"	"	—
Kansas	"	"	"	9 in.	"	"	"
Minnesota	"	"	"	"	"	"	"
New Hampshire	"	"	"	"	"	"	"
Vermont	"	"	"	"	"	"	"
South Carolina	"	"	18.5	11 in.	"	8 12-in. 20 3-in.	—
Michigan	"	"	"	"	"	"	—
Delaware	"	20,000	21.0	"	"	10 12-in. 14 5-in.	—
North Dakota	"	"	"	"	"	"	—
Arkansas	Monitor.	3,235	11.5	"	11 in.—10 in.	2 12-in. B. L. R. 4 4-in. R. F. G.	3 6-pounders. 6 1 " 2 Colts.
Florida	"	"	"	"	"	"	"
Nevada	"	"	"	"	"	"	"
Wyoming	"	"	"	"	"	"	"
California	Armored Cruiser.	13,680	22.0	6 in.—5 in.	6½ in.—6 in.	4 8-in. B. L. R. 14 6-in. R. F. G. 18 3-in. R. F. G.	12 3-pounders. 8 1 " 10 small guns.
Colorado	" "	"	"	"	"	"	"
Maryland	" "	"	"	"	"	"	"
Pennsylvania	" "	"	"	"	"	"	"
South Dakota	" "	"	"	"	"	"	"
West Virginia	" "	"	"	"	"	"	"
Washington	" "	14,500	"	5 in.	10 in.—10 in.	4 10-in. B. L. R. 16 6-in. R. F. G. 22 3-in. R. F. G.	12 3-pounders. 2 1 " 10 small guns.
Tennessee	" "	"	"	"	"	"	"
Montana	" "	"	"	"	"	"	"
North Carolina	" "	"	"	"	"	"	"
Charleston	Semi-armored Cruiser.	9,700	"	4 in.	Deck / 3 in.—2 in.	14 6-in. R. F. G. 18 3-in. R. F. G.	12 3-pounders. 24 small guns.
Milwaukee	" "	"	"	"	"	"	"
St. Louis	" "	"	"	"	"	"	"

UNARMORED CRUISERS AND GUNBOATS.

Name.	Type.	Displacement in Tons.	Speed in Knots.	Protective Deck.		Armament.	
				Slopes.	Flat.	Main.	Secondary.
Salem	Cruiser Scout.	3,750	24			12 3-in. R. F. G.	
Chester	"	"	"			"	
Birmingham	"	"	"			"	
Chattanooga	Semi-protected Cruiser.	3,200	16.5	2 in.—1 in.	½ inch.	10 5-in. R. F. G.	8 6-pounders. 6 small guns.
Cleveland	" "	"	"	"	"	"	"
Denver	" "	"	"	"	"	"	"
Des Moines	" "	"	"	"	"	"	"
Galveston	" "	"	"	"	"	"	"
Tacoma	" "	"	"	"	"	"	"
Reina Mercedes	Unprotected Cruiser.	3,090	17.0				
Don Juan de Austria	Gunboat.	1,130	14.0			4 5-in. R. F. G.	4 6-pounders. 4 Colts.
General Alava	"	1,390	10.5				6 Nordenfelts.
Isla de Cuba	" Formerly Spanish.	1,125	14.0	2½ in.	1½ inches.	4 4-in. R. F. G.	4 6-pounders. 4 Colts.
Isla de Luzon	" "	"	"	"	"	"	4 6-pounders. 4 Colts.
*Alvarado	" "	106	19.0				2 3-pounders. 2 Colts.
Gunboat No. 16	"						

* Twenty-one of this type of Gunboat captured or purchased from Spain, varying from 42 to 569 tons displacement and from 8 to 19 knots speed.

DESTROYERS, TORPEDO BOATS, AND SUBMARINES.

Name.	Type.	Displacement in Tons.	Speed in Knots.	Armament.	
				Torpedo Tubes.	Guns.
Bainbridge Barry Chauncey Dale Decatur Paul Jones Perry Preble Stewart	Torpedo-boat Destroyers.	420	29.0	2 18-inch Whitehead.	2 3-inch and 5 6-pounders R. F. G.
Lawrence Macdonough Truxton	Torpedo-boat Destroyers.	402	30.0	2 18-inch Whitehead.	2 3-inch and 5 6-pounders R. F. G.
Whipple Worden	Torpedo-boat Destroyers.	433	30.0	2 18-inch Whitehead.	2 3-inch and 5 6-pounders R. F. G.
Hopkins Hull	Torpedo-boat Destroyers.	408	29.0	2 18-inch Whitehead.	2 3-inch and 5 6-pounders R. F. G.
Bagley	Torpedo-boat.	175	29.2	3 18-inch Whitehead.	3 3-pounders R. F.
Bailey	"	280	30.2	2 " "	4 6-pounders R. F.
Barney	"	175	29.1	3 " "	3 3-pounders R. F.
Biddle	"	175	28.0	3 " "	" "
Blakely	"	200	26.0	3 " "	" "
Davis	"	154	23.4	3 " "	3 1-pounders R. F.
Dahlgren	"	146	30.5	2 " "	4 1-pounders R. F.
De Long	"	200	26.0	3 " "	3 3-pounders R. F.
Farragut	"	279	30.1	2 " "	4 6-pounders R. F.
Fox	"	154	23.1	3 " "	3 1-pounders R. F.
Goldsborough	"	247	30.0	2 " "	4 6-pounders R. F.
MacKenzie	"	65	20.1	2 " "	1 1-pounder R. F.
Nicholson	"	174	26.0	3 " "	3 3-pounders R. F.
O'Brien	"	174	26.0	3 " "	3 3-pounders R. F.
Rowan	"	182	27.0	3 " "	4 1-pounders R. F.
Shubrick	"	200	25.0	3 " "	3 3-pounders R. F.
Stockton	"	200	24.7	3 " "	3 3-pounders R. F.
Stringham	"	340	30.0	2 " "	7 6-pounders R. F.
T. A. M. Craven	"	146	30.5	2 " "	4 1-pounders R. F.
Thornton	"	200	26.0	3 " "	3 3-pounders R. F.
Tingey	"	165	26.0	3 " "	" "
Wilkes	"	165	26.5	3 " "	" "
Holland	Submarine.	74	8	1 Torpedo Tube.	
Adder	"	122½	8½—7½	" "	
Grampus	"	"	"	" "	
Moccasin	"	"	"	" "	
Pike	"	"	"	" "	
Shark	"	"	"	" "	
Porpoise	"	"	"	" "	
Plunger	"				
Cuttlefish	"	175	10 -9	" "	
Tarantula	"	"	"	" "	
Viper	"	"	"	" "	
Octopus	"	200	11—10	" "	

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Display case, A. E. Lyons 871,877
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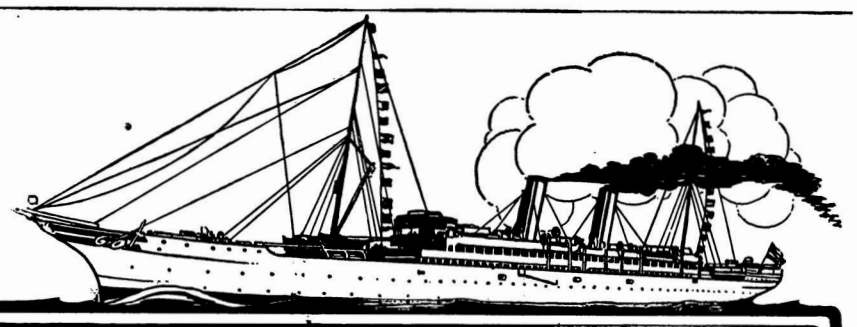

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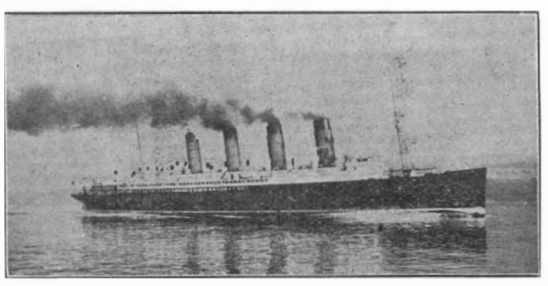

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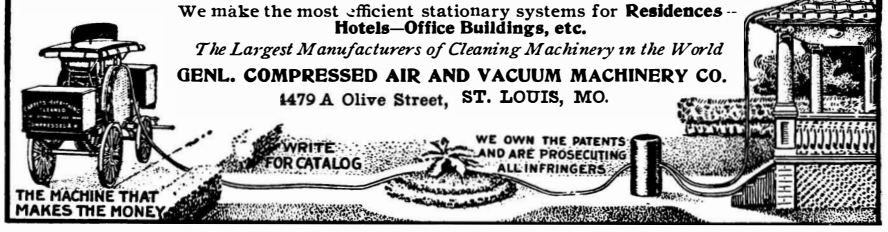

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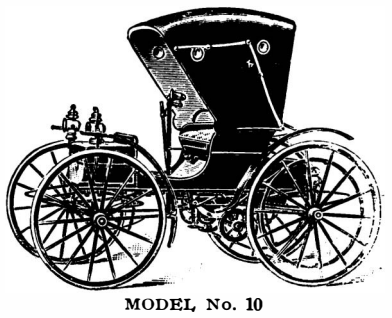

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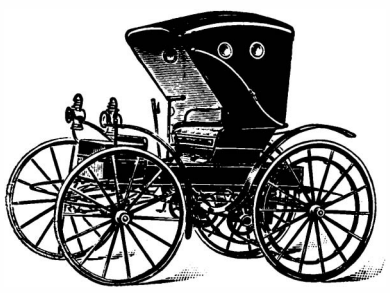

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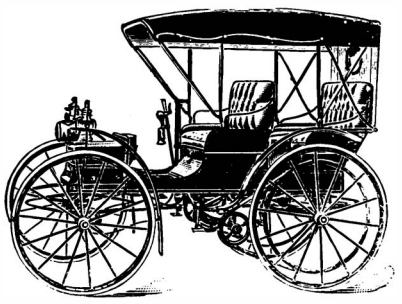

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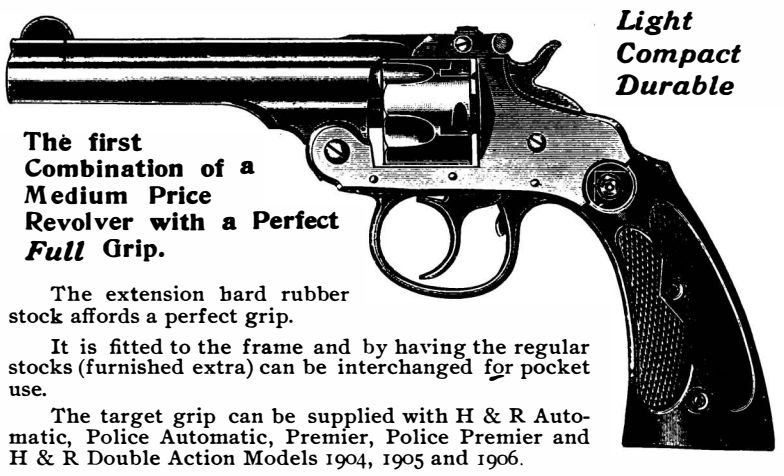

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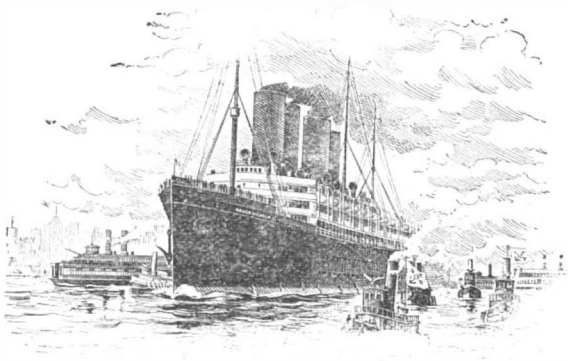

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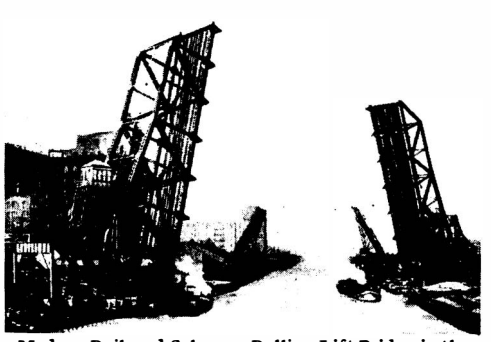

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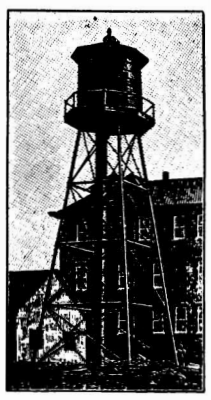

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Scientific American Supplement 1564 contains an article by Lewis A. Hicks, in which the merits and defects of reinforced concrete are analyzed.

Scientific American Supplement 1551 contains the principles of reinforced concrete with some practical illustrations by Walter Loring Webb.

Scientific American Supplement 1573 contains an article by Louis H. Gibson on the principles of success in concrete block manufacture, illustrated.

Scientific American Supplement 1574 discusses steel for reinforced concrete.

Scientific American Supplements 1575, 1576, and 1577 contain a paper by Philip L. Wormley, Jr., on cement mortar and concrete, their preparation and use for farm purposes. The paper exhaustively discusses the making of mortar and concrete, depositing of concrete, facing concrete, wood forms, concrete sidewalks, details of construction of reinforced concrete posts.

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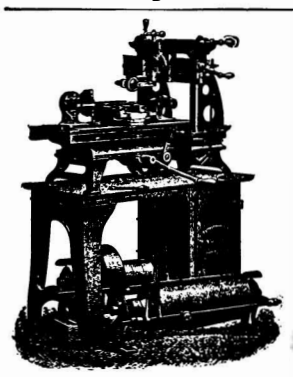

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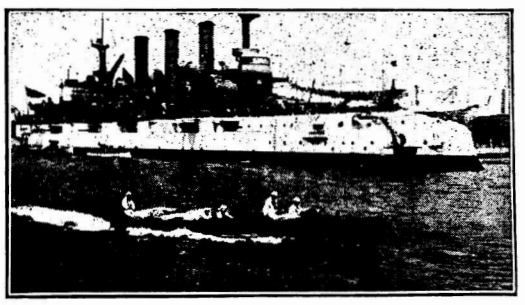

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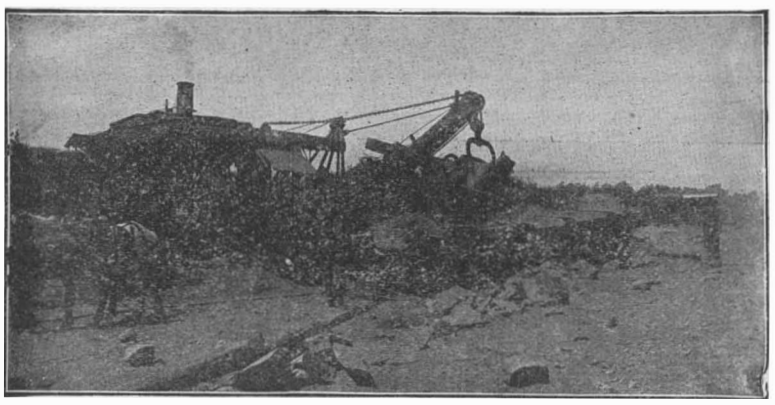

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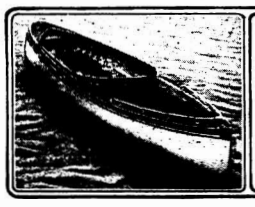

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NEW BOOKS, ETC.

GRINDING AND TAPPING TOOLS, PROCESSES, AND FIXTURES. By Joseph V. Woodworth. New York: Hill Publishing Company. 8vo.; cloth; 162 pages illustrated. Price, $2.

In machine shops the development of uses for emery wheels has been remarkable, and there is to-day an immense amount of work done with the emery wheel that a few years ago it was not considered possible to handle in this way. "Lapping and Grinding" is the very latest work on the subject, and is written in a clear, practical manner by a practical man. It should be in the hands of every mechanical engineer and up-to-date mechanic. The following list of contents is its best recommendation: Grinding; Conditions, Rules, Methods, Processes, Machines and Attachments for Accurate Grinding; Use and Preparation of Abrasives; Laps and Lapping; Construction and Use of Tools and Processes for Finishing Gages, Tools, Dies, and Machine Parts to Accurate Dimensions, Construction, Use and Operation of Grinding Fixtures and Jigs for Finishing Repetition Parts and Articles of Metal, Small Hardened and Tempered Steel Parts and Special Work; The Hardening and Tempering of Interchangeable Tool Steel Parts of Delicate Structure which Require to be Ground and Lapped Afterward; Percentage of Carbon Crucible Steel Ground Parts and Tools Should Contain.

AGGLUTINANTS OF ALL KINDS FOR ALL PURPOSES. By H. C. Standage. New York: D. Van Nostrand Company, 1907. Cloth; 5½ x 8½ inches; 247 pages; 508 recipes and numerous notes. Price, $3.50.

It is seldom that one finds such an excellent collection of recipes for glues and similar compounds so conveniently arranged as they are in this work. They are arranged under the headings of the trades to which they are of greatest use, and are also referred to in a complete index. Every recipe has been tested and found to do what is claimed of it.

THE CONSTRUCTION OF DYNAMOS. (Alternating and Direct-Current.) A Text Book for Students, Engineer-Constructors, and Electricians in Charge. By Tyson Sewell. With nearly 550 illustrations and diagrams specially drawn and engraved for this work. London: Crosby, Lockwood & Son. New York: D. Van Nostrand Company. 8vo.; cloth; 316 pages. Price, $3.

This work deals in a single volume of handy size with the theory, design, and construction of dynamos, both alternating and direct-current. The treatment is sufficiently detailed to make it useful as a textbook for students and apprentices as well as helpful as a reference book to engineers.

The early chapters deal with fundamental principles; polyphase currents, however, being treated later on as an introduction to polyphase alternators. The examples of design introduced in the work are for illustration only, since the work of designing falls to the lot of comparatively few men; most manufacturers having standardized particular lines, which can be made to fill the majority of requirements, with slight modification.

SHAFT SINKING UNDER DIFFICULT CONDITIONS. By J. Riemer. Translated from the German by C. R. Corning and Robert Peele. New York: John Wiley & Sons. 8vo.; cloth; 19 plates, 176 pages. Price, $3.

Little need has arisen in America to exploit mineral beds that are very difficult to work. Where the difficulties have seemed too great, such bodies have been allowed to remain undeveloped, and deposits of easier access have been successfully sought. In Germany the conditions are different. Mining operations are carried on there under conditions that we would consider too unfavorable to be profitable. It is with some special cases of such a nature that this work deals; cases in which the soil was so permeated with water that the difficult freezing mthod, as well as others, had to be resorted to before the operations could be completed with success, or indeed could be completed at all.

STANDARD POLYPHASE APPARATUS AND SYSTEMS. By Maurice A. Oudin. New York: D. Van Nostrand Company. London: Sampson Low & Co. 8vo.; cloth; 369 pages, 207 illustrations and diagrams. Price, $3 net.

This book, first issued in 1899, has reached its fifth edition and has been enlarged and brought up to date. Full of practical information and containing a number of useful tables, it forms a valuable reference book for men who operate or are interested in alternate current machinery.

THE MANUAL OF STATISTICS. New York: The Manual of Statistics Company, 1907. 8vo.; pp. 1064. Price, $5.

The Manual of Statistics for 1907, being the twenty-ninth annual issue of that standard reference publication, has just made its appearance. As usual, it contains in concise and complete form the information regarding railroad and industrial corporations of the United States and Canada, government securities, mining stocks, and the grain and cotton stocks which are required by investors, speculators, and stock market interests. In fact, the 1,064 pages of the compact and handsome volume present a greater fund of data and statistics of a practical character than any other work on such subjects; its utility being enhanced by an arrangement rendering reference to the contents of any section easy and satisfactory. The present edition also devotes much attention to the newer mining companies whose stocks have become such a feature in the stock markets of the United States, a class of organizations and securities on which full and accurate information is often difficult to obtain. It gives throughout evidence of accuracy and careful compilation and is brought down to date in its descriptive and statistical details, making the volume one which investors and all who are interested in the financial and other markets of the country cannot afford to be without.

DICTIONARY OF ENGINEERING TERMS IN ENGLISH AND SPANISH. With Indexes in Both Languages. By Andres J. R. V. Garcia. New York: Spon & Chamberlain, 1906. 4½ x 5½ inches; cloth; 150 pages. Price, $1.

A handy technical dictionary in Spanish and English is a necessity for those who are engaged in the constantly expanding relations with the Latin-American countries. Mr. Garcia's work is furnished with an index in the two languages, lessening greatly the work of translating from Spanish into English.

LLOYD'S REGISTER OF AMERICAN YACHTS. New York: Lloyd's Register of Shipping, 15 Whitehall Street. 8vo. large; pp. 410. Price, $7.50.

The growing of yachting in America shows itself in the steadily-increasing size of Lloyd's Register of American Yachts. The volume before us for 1907 contains over 400 pages and records the full particulars of nearly 3,500 yachts owned in the United States and Canada, the name and address of the owner of each yacht being also given. The information regarding the yachts includes the material of construction, type, rig, sail area, official number, signal letter, tonnage, length over all and on the waterline, extreme breadth and draft, name of the designer and builder, place and date of launch, and particulars of the machinery. Very handsome are the pages of the book which are devoted to the colored illustrations of private signals, of which there are 1,872, and of club burgees, 300 in number. The officers of nearly 350 clubs and yachting associations are also given.

THE ROMANCE OF STEEL. The Story of a Thousand Millionaires. By Herbert N. Casson. New York: A. S Barnes & Co., 1907. Cloth; 376 pages, 63 portraits. Price, $2.50.

As its title suggests, this is a popular book, dealing briefly with the rise of the iron industry in the United States, and at length with the careers and personalities of the men who have directed the wonderful expansion which followed, at first slowly, the discoveries of Kelly and Bessemer. The book contains few statistics, and those in popular form; the author is more interested in giving glimpses of the real men behind the steel. We see the men rather than the millionaires, and understand the capacities in each which fitted them to act as cogs in the great machine of the greatest American industry.

ANNUAL REPORT OF THE BOARD OF SCIENTIFIC ADVICE FOR INDIA FOR THE YEAR 1905-06. Calcutta: India Government Central Press. 8vo.; paper.

A *résumé* of the official scientific inquiry carried on in India.

DIE TECHNOLOGIE DER APPRETUR. EIN LEHRBUCH ZUM UNTERRICHT AN TECHNISCHEN FACHSULEN WIE ZUM SELBSTUNTERRICHT. Von Dr. A. Garswindt. Wien und Leipzig: A. Hartleben's Verlag. With 155 illustrations. 8vo.; paper bound; 317 pages.

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(*Continued from page 409.*)

16,500 horse-power. The "Connecticut" is particularly interesting, at the present time, as having been selected as the flagship of the Pacific fleet, special accommodations for this purpose having been provided when the ship was under construction. It is also to be remembered that the "Connecticut" was built entirely at a government navy yard, contemporaneously with the construction of the "Louisiana" at a private yard. The high character of the work on the "Connecticut," and the fact that she was built in the same time as the "Louisiana," and that her extra cost, in view of the higher pay and shorter hours of government employees, was less than was expected, has established, conclusively, the ability of the government to do the very highest character of work at a reasonable cost in its own yards. The other four ships of this class differ slightly from the "Connecticut" in the arrangement of the protective deck and in the thickness of the

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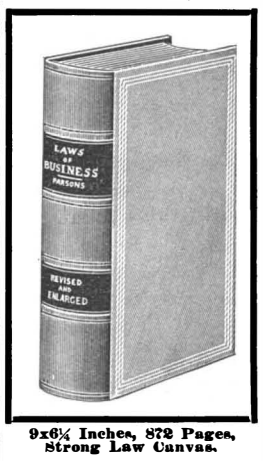

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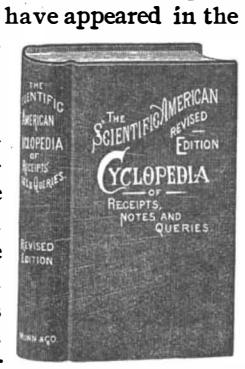

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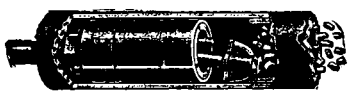

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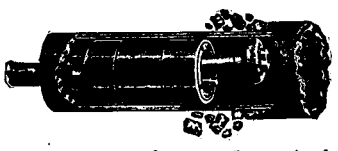

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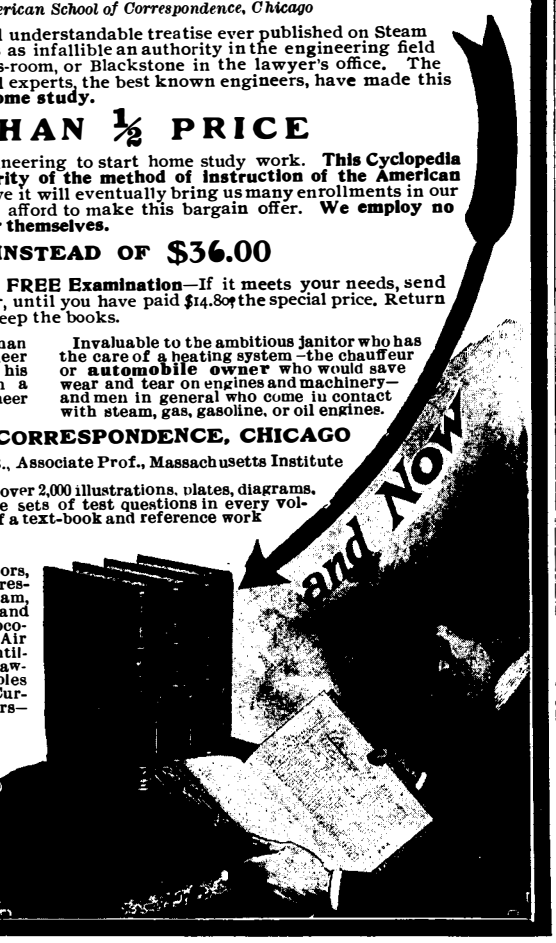

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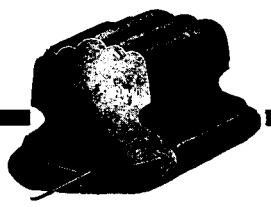
belt, which has been reduced amidships from 11 to 9 inches.

FIRST-CLASS BATTLESHIPS "IDAHO" AND "MISSISSIPPI."

The "Idaho" and the "Mississippi," building at Cramps, are smaller editions of the "Connecticut." With a length of 375 feet, a beam of 77 feet, and draft of 24 feet 8 inches, they displace 13,000 tons. On this displacement they carry four 12-inch, eight 8-inch, and eight 7-inch guns; so that their main battery is less than that of the larger ship by only four 7-inch pieces. They have two 21-inch submerged torpedo tubes, and their armor plan is practically the same as that of the "Kansas." The 3,000 tons difference in displacement between the "Idaho" and the "Kansas" shows its effect most strongly in the engine room and the speed, the horse-power being only 10,000 as against 16,500, and the speed one knot less, or 17 knots an hour. It is to be regretted that such powerful ships as these should, in this year of our Lord 1907, and in this age of 21-knot battleships, be going out to the trial course with the expectation of doing no better than 17 knots an hour.

FIRST-CLASS BATTLESHIPS "SOUTH CAROLINA" AND "MICHIGAN"

The battleships "South Carolina" and "Michigan," now being built by the Cramps and the New York Shipbuilding Company respectively, are of particular interest, because they were the first of our battleships to be designed after the conclusion of the Russo-Japanese war, and therefore embody the experience gathered during the naval operations of that great conflict. The most marked departure from the battleships which preceded them is seen in the complete elimination of the intermediate and secondary batteries which, in our earlier ships, consisted of a large number of 5-inch, 6-inch, 7-inch, or 8-inch guns. The customary number of guns in the main battery has been doubled, so that instead of four 12-inch, the new ships carry eight such guns mounted in four turrets. A numerous battery of small rapid-fire guns is retained, as a defense against torpedo-boat attack. In length and displacement the new vessels are approximately the same as the "Connecticut," though their beam is 4 feet greater and they have half a knot more speed. In general appearance they will differ greatly from any of our other battleships. The most noticeable novelty will be the four 12-inch gun turrets mounted in pairs on the axial line of the ship, two forward and two aft of the superstructure. Since the displacement of the ships was limited by act of Congress to 16,000 tons, it became necessary, in order to save weight, to reduce the freeboard of the ship by the depth of one deck (say about 8 feet) from the after end of the superstructure to the stern. The two turrets of each pair are mounted in close proximity to each other, one pair of guns being given sufficient command to fire across the roof of the turret of the adjoining pair. Experiments carried out on a full-sized scale have shown that there is no blast interference, and this being the case, all of the 12-inch guns are available for training through a maximum arc of fire of 270 degrees. It is possible to fire four guns ahead or astern, and eight on each broadside. The forward guns have a command of 24 feet and 32 feet respectively, and the after pair of 24 and 16 feet respectively. It is unfortunate that our naval constructors did not have more displacement at command, so that they could have carried the after four guns to the same height as the forward guns, and have given the ships a higher freeboard and engine power sufficient to bring their speed up to that of the latest "Dreadnought" type, say 20 to 21 knots. The armor protection has been carefully worked out, its most important element being a water-line belt 11 inches thick, 8 feet wide, and over 300 feet in length. The casemate armor above this will be nearly 300 feet long, 8 feet in width, and



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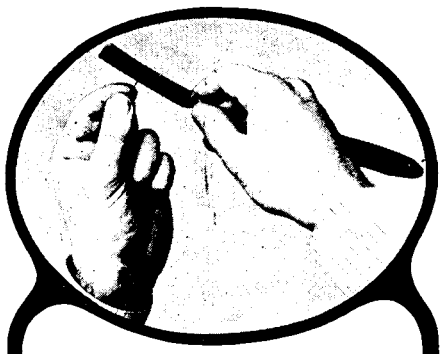

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from 8 to 10 inches in thickness. With this is associated triangular athwartship armor 10 inches thick, fitted at the after end of the armor belt between the protective deck and the extension of the flat protective deck. There will be an athwartship armor bulkhead 10 inches thick, extending entirely across the ship at the forward end of the belt. Other armor bulkheads will connect with the outside casemate plating. The advantage of carrying all of the 12-inch guns on the center line of the ship is seen in the fact that the "South Carolina" and "Michigan" have the same broadside fire as the "Dreadnought," which is of more than 2,000 tons greater displacement.

THE 20-000-TON "NORTH DAKOTA" AND "DELAWARE."

By far the most important ships building for our navy to-day are the two big battleships "North Dakota," under construction at the Fore River yard, and "Delaware," now building at Newport News, Va. These ships, to use the current phrase, are the "answer" of the United States to the battleships of the "Dreadnought" type, which are being constructed for other navies. On the cover of this issue is a drawing of the "Delaware," which gives a good impression of her lofty freeboard, great length, and formidable fighting qualities. These ships are a great advance upon the "South Carolina" and "Michigan"; for in them it was possible to remedy the defects of low freeboard and low speed, while the battery is greater by two 12-inch guns and a powerful secondary battery of 5-inch pieces. Furthermore, the great displacement of these ships has made it possible to give them an amount of armor protection never before approached. The speed has been raised to 21 knots, and the bunker capacity is also very large. The system of mounting all guns on the center line of the ship, adopted in the "South Carolina" and "Michigan," has been followed, with the result that their broadside fire is twenty-five per cent greater than that of the "Dreadnought," and will probably equal that of any battleship afloat at the time they will go into commission. The ships will be 510 feet on the waterline, 85 feet 2⅝ inches in maximum breadth, and will displace on trial 20,000 tons on a mean draft of 26 feet 10¾ inches. On trial they must carry 1,000 tons of coal in bunkers whose total capacity is 2,500 tons, and the speed must be 21 knots.

The "Delaware" and her sister follow the "Dreadnought" type, in having a long forecastle deck extending from the bow to about the center of the ship. The main deck, below this, has the same freeboard as the "Connecticut," or say about 20 feet. The forecastle deck has a freeboard of 28 feet. The 12-inch guns are mounted as follows: Forward is a two-gun turret, with the axes of its guns 24 feet above the waterline. Close abaft of this, with its barbette of sufficient height for the guns to clear the roof of the forward turret, is another turret, carrying two 12-inch guns. Immediately abaft the break of the forecastle deck are two two-gun turrets, the guns of the forward pair firing over the roof of the after pair. These guns, like those on the forecastle deck, are located on the axis of the ship. Abaft is the fifth turret, so placed that its guns have a command of 24 feet above the waterline. It will be seen from this description how excellently are placed the guns of the main battery. Four of them have a command of 24 feet, four of 30 feet, and one pair, the second pair from the bow, is carried at a height of about 36 feet above the water. The battery of fourteen 5-inch guns for repelling torpedo-boat attack is mounted in broadside; two of the guns forward in the bow in sponsons, so arranged that each has a slight arc of fire across the axis of the ship. Two others are mounted astern on the gun deck, and the other ten in broadside in a central battery. The armor protection is unusually complete, superior even to that of the "South Carolina" and "Michigan." The belt is 11 inches thick by 8 feet in width, and above it the side of the ship is protected by a secondary belt 7 feet 3 inches wide and 10 inches thick. These two belts afford a reasonable assurance of the maintenance and stability of the ship under battle conditions. Above the main casemate armor, amidships, the side is protected by 5-inch armor, behind which are mounted ten of the 5-inch guns. This armor also affords protection to the bases of the smoke-pipes. The percentage of weight allotted to hull and armor in these ships is considerably greater than the percentage of such weights allotted to similar purposes in the largest battleship now afloat. The contract speed is 21 knots, and this is to be obtained in the "Delaware" by reciprocating engines, and in the "North Dakota" by turbines of the Curtis type.

WARSHIP TONNAGE OF THE PRINCIPAL NAVAL POWERS.

(*Continued from page 414.*)

what is, after all, the most important point of all, namely, the personnel. It is not so much the gun as the man behind the gun that determines the issue. It is not so much the speed and cruising radius of the ships, or the judicious emplacement of their batteries, or their handy maneuvering qualities, that determine the issues of a campaign, as it is the efficiency, prudence, dash, and all-round genius of the officers who fight the ships. Moreover, in order to get the best results out of a fleet, not only must the personnel be of the highest efficiency, but it must be sufficiently adequate in numbers; for modern wars have shown that, in the wear and tear of a bitterly-fought conflict, there is nothing that calls for a larger reserve than the personnel, both officers and men. Hence, the great significance of the comparison of the personnel shown on the accompanying diagram. The results are striking, and certainly, for the United States, very disconcerting. Although in the number and displacement of our ships we stand second on the list, in the number of enlisted men we stand last; far below Japan, whose total tonnage is not more than about sixty per cent of our own. With a total tonnage of 611,616 against Japan's tonnage of 374,701, we have only 18 flag officers against Japan's 55; 182 captains and commanders, against Japan's 245; 751 other line officers and engineers, against Japan's 1,751; and 34,062 enlisted men, against Japan's 41,070, Germany's 42,400, France's 51,926, and England's 98,973 enlisted men.

THE UNITED STATES NAVAL ACADEMY.

(*Continued from page 415.*)

curring. The baseball and football games of the midshipmen are of intense interest to the officers. For exercise there is golf and tennis, and some ride. All in all, it is a pleasant, interesting life.

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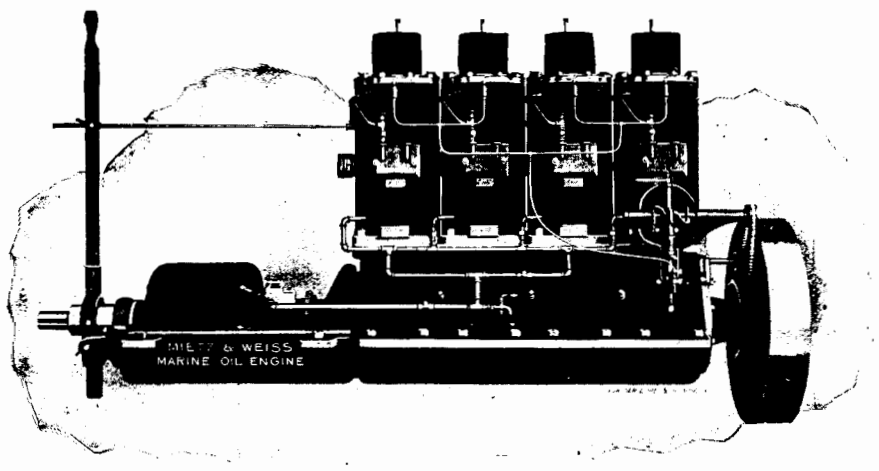

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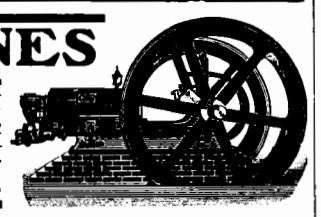

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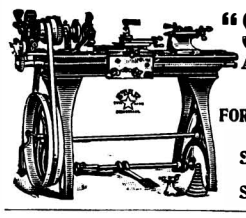

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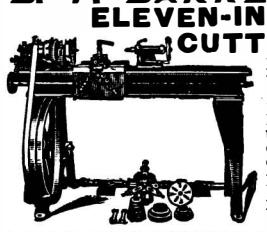

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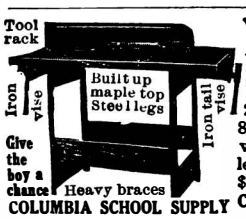

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certain studies, and later cut lectures if they so please, and are not required to give a very complete account of themselves. But the eight hundred and fifty midshipmen at Annapolis all go to bed at the same time, ten o'clock, and get up at the same time, six o'clock. They all live in rooms exactly alike, with furniture after the same pattern. They march to and from meals together, to and from recitations together. Should a midshipman be absent from any assembly or formation where he is due, it will become known instantly, and the cause of his absence will be ascertained. At any one time all midshipmen will be dressed exactly alike; if one midshipman is wearing rubber overshoes, all will be. Midshipmen of one class all study exactly the same lessons each day, and recite on them in the same periods. Study hours and recitations occupy the midshipman until half-past three, and drills take place between 3:40 and 5 P. M. On a particular day twenty different kinds of drills may be going on in all of the different departments. In light of the foregoing, it is seen that a most intimate personal control of each midshipman is necessary, and their organization into a naval brigade effects this. If there was not this intimate control, if there was not a complete hold on each midshipman all of the time, there would be lost an incalculable amount of time if nothing else.

But there is something else this organization effects; as previously said, its purpose is twofold. This second purpose is the effect upon the character of these young men. Each midshipman must constantly every day account for himself to some one higher up in authority than himself. Unconsciously he acquires the habit of taking great pains to learn what his exact duties and responsibilities are. As a midshipman he learns the meaning and necessity of regulations and discipline. When he enters these terms have no more meaning to him than are obtained from dictionary definitions. He is then bewildered with the multiplicity of rules that regulate his life. He learns their necessity by hard knocks, by punishment for ignorance or violation of them. When he graduates, four years later, these regulations are part of his being, his whole personality is saturated with them. He then reports aboard ship and finds the same spirit controlling the ship that he had become so used to. As a result he instantly feels at home, he knows the regulations that control his own action, and he knows how to apply and enforce the regulations upon the enlisted men that come under his authority.

A most important quality required of the naval officer is the habit of command. This can never be learned from books, and the man who can successfully command must also know how to obey. The four years' life of the midshipmen at Annapolis is a life of obedience. In the last year, in addition, the midshipman begins to acquire the habit of command; under the direction of the commandant and his assistants, the discipline officers, the brigade of midshipmen is officered and controlled by the senior classmen. And so perfectly is this done in spirit and practice, that the authority of cadet officers is no more questioned by the midshipmen than is the authority of the officers aboard ship by enlisted men of the crew.

The brigade is commanded by the cadet commander. It is divided into two battalions, each commanded by a cadet lieutenant commander. Each battalion is composed of six companies, commanded by cadet lieutenants, assisted by cadet junior lieutenants, and cadet ensigns. The companies are further divided into crews, commanded by cadet petty officers. Each of the cadet officers has particular and responsible duties in connection with the midshipmen under his direct orders, and the sequence of authority is swift and certain.

The brigade of midshipmen is, under the commandant's direction, a self-controlled body. A discipline officer is always present at the different formations, but he is never required to do more than give an order in a quiet tone to the senior midshipman present.

In carrying out inspections, in enforcing regulations and reporting infractions thereof, the discipline officers are always assisted by the cadet officers. It is the hearty co-operation of these that is depended on, and that counts much toward sustaining the high standard of duty and honor that animates the brigade collectively and midshipmen individually. This co-operation exists and is effective, and the writer is glad to record his appreciation of the earnest efforts of these splendid young officers.

STUDIES.

Instruction at Annapolis is given on the personal recitation system. Each class is divided into sections of about ten men each. There are three one-hour recitations each day. With so few in a section, each midshipman gets much personal instruction.

The first two years' book work is not naval in character. It is principally composed of mathematics, but also includes the study of rhetoric, naval history, physics and chemistry, mechanical drawing, and French and Spanish. As far as these studies are concerned, they might be pursued in any educational institution, perhaps with as good results as at the Naval Academy. This preliminary mental training is necessary before the work in the professional scientific branches is commenced. But outside of these studies in the first two years of his course, the midshipman has invaluable training in the various daily drills, in naval organization, and in the naval spirit and discipline that envelop him.

In the last two years the studies are entirely professional. The time is devoted to seamanship, navigation, marine and electrical engineering, ordnance and gunnery, naval construction, and kindred subjects. The different department drills keep pace with the subjects taught in the class rooms, and as far as possible are allied to them.

DRILLS.

The scheme of the practical exercises is planned with reference to the class the midshipman is in. As a fourth-class man he will be a rear-rank private, pull an oar in a boat, haul on ropes and personally furl sail, occupy the most unimportant great-gun station in a turret, and fill an ordinary seaman's billet on the summer practice cruise. As a first-class man he will occupy a position of responsibility in these drills, will receive instruction himself and at the same time will assist in instructing the lower classmen. These drills are of great variety. The purpose is that when a midshipman is graduated and sent to a cruising ship, he will himself have performed every kind of work required of the enlisted man, and thus he can instruct the latter. The drills are in dancing, boxing, fencing, building and managing steam and electric machinery, target practice with small arms and great guns, artillery, infantry, torpedoes, signals, tactics, boat sailing and rowing, and seamanship, both in steam and sailing vessels. Modern war vessels take the midshipmen on an ocean-going practice cruise each summer, where each midshipman is initiated and practised in duties suitable to his state of progress. As a senior classman he will have the duties of a ship's officer.

PRIVILEGES AND CUSTOMS.

Privileges depend upon class rank and conduct. The first-class man has freedom of liberty to Annapolis to a greater extent than is accorded the fourth-class men. Midshipmen are graded in one month according to the number of demerits assigned the previous month. There are three conduct grades. A midshipman receives fifty demerits if he wears non-regulation clothes, and would receive fewer for a less serious offense, three for instance for being late to formation.

Midshipmen are much influenced by class sentiment. Speak unkindly of a

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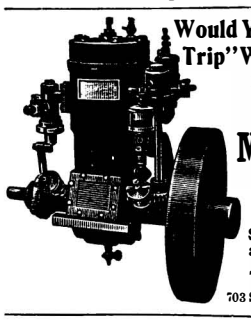

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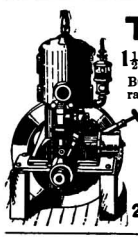

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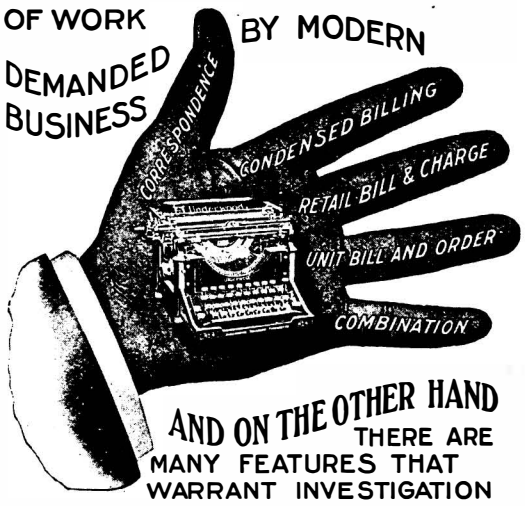

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class, and every member of it is hurt and indignant. Appeal in any particular case to the better feeling of a class, and the entire class will respond as one man. Class customs are handed down to posterity. To-day peculiar sentiments exist that were in vogue over twenty years ago, to the writer's knowledge, and undoubtedly long before that.

Relaxation takes the form of outdoor sports and athletics of all kinds. There are track meets of running and jumping, throwing the hammer and vaulting. Baseball, football, tennis, basket ball, and other contests occur.

The midshipmen have their glee club, and most years during the winter give a minstrel show and musical performance, to which officers and their families are invited.

It is an exacting, but withal a joyous, interesting life. On an average, but fifty to sixty per cent of those who enter are graduated. The rest, failing in some way to give satisfaction, are dropped in the different years as the class progresses.

The sentiment is that a midshipman must be a gentleman in all that the word implies. This is the obligatory standard of life that exists among these young men.

The training in all respects is entirely controlled by naval officers. As these officers are constantly fresh from sea service, it means that the Naval Academy preparation reflects the ideas of the naval service at large.

SIMPLE EXPLANATION OF MODEL BASIN METHODS.

(*Continued from page 420.*)

the model of a submerged strut, for example, might be negligible, while eddying around the full-sized strut of the actual ship would be serious. In the first case, the law of comparison would apply for practicable speeds. In the second place, it would not apply except as a rough approximation. As, however, eddy resistance is not a large proportion of the residuary resistance, and as the law of comparison applies fully to a portion of the eddy resistance and with fair approximation to the remainder, we are warranted in relying fully upon the law of comparison as regards residuary resistance. It is probably more reliable in the determination of the residuary resistance of a full-sized ship than the methods we must use for estimating its frictional resistance.

It is in connection with propellers that the law of comparison becomes an unsafe guide. It is easy to make experiments with model propellers in a model basin and to apply the law of comparison to the results for the purpose of determining the thrust and power of full-sized propellers. This method has given good results in some cases and in other cases has failed, and the law of comparison has been sometimes discredited on this account. As a matter of fact, the fault is not with the law of comparison, but with the wrong use of it. A 12-inch model propeller with its center, say, one foot below the surface is working under a head of about 33 feet due to the atmosphere and one foot due to its submergence, or 34 feet in all. A 12-foot propeller submerged correspondingly 12 feet below the surface is working under a head of 33 feet due to the atmosphere plus 12 feet due to submergence, or 45 feet in all. The head under which it should work to correspond accurately with the model propeller would be 12 x 34, or 408 feet. The law of comparison should not be applied unless the conditions are such that it is applicable. It happens, however, that for moderate thrusts and speeds the motions around the model propeller and the full-sized propeller, in spite of the fact that they do not work under the proper relative heads, are essentially similar, and the ultimate reactions being due not to the pressures but to the motion given the water, the law of comparison does reasonably apply.

When, however, the full-sized propeller

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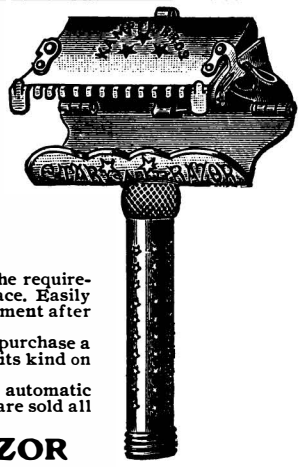

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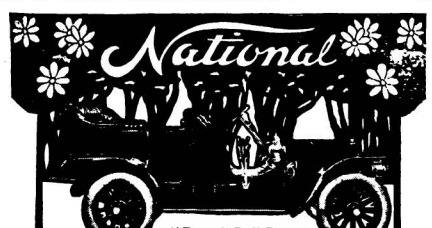

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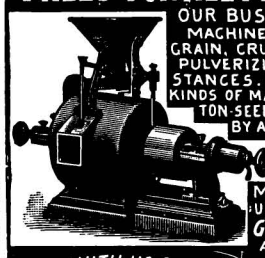

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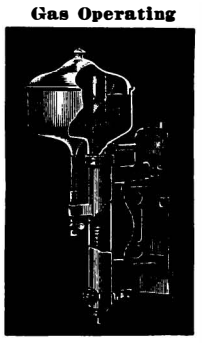

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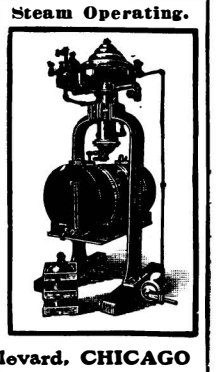

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From model basin experiments we are able to determine more accurately than by any other known method at present the effective horse-power required to pull a ship through the water. But what we need to estimate in practice is the indicated horse-power required to be shown by the propelling machinery in order to drive the ship. The conditions are somewhat complicated. Of the indicated horse-power shown in the cylinders of a reciprocating engine, a varying proportion is absorbed in friction of the machinery itself, the remainder being delivered to the propeller. The propeller utilizes a certain proportion of the power which reaches it, the remainder being wasted. Furthermore, the propeller is not working in undisturbed water, but in the wake which is dragged after the ship and which, acting on the propeller, virtually helps to push the ship ahead, thereby gaining power. But, again, the propeller by its suction tends to suck the ship astern, thereby increasing its resistance. It is on account of these numerous varying factors that we need to establish an average ratio or a utilization coefficient, which is commonly called the efficiency of propulsion and is the ratio between the effective horse-power necessary to pull the ship at a given speed and the indicated horse-power necessary to propel it at the same speed. This ratio can only be satisfactorily established by comparison between numerous trial results of actual ships and model basin results, a fact which renders it of great importance to have accurate trials of full-sized ships whose model results are known.

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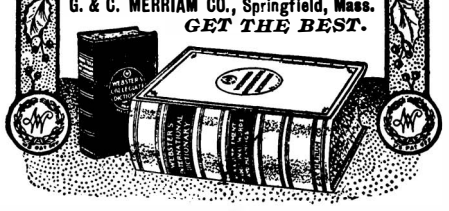

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the purpose of estimating, and, in the usual run of cases, it should not fall below that figure. This per cent, moreover, is usually based upon the effective horse-power of the bare hull of the ship. In practice, for vessels with unusually efficient machinery and few appendages, the efficiency of propulsion thus figured may rise as high as 60 per cent. But it is hardly safe when making estimates to rely upon such a high figure, it being obviously desirable to provide a reasonable margin.

It will be evident from the nature of the case that the accumulated records of experiments of the model basin increase in value as they increase in number, and after several years of systematic experimentation it is possible from the records of the United States model basin without making and trying a model to make a fair approximation to results to be expected of almost any normal type of vessel. Fig. 3 illustrates such a case. Suppose we wish to determine for an Atlantic liner of 40,000 tons displacement and 800 feet in length the approximate curves of effective horse-power according as the boat is made with a fine cylindrical coefficient or a full cylindrical coefficient. The cylindrical coefficient is the ratio between the actual submerged volume of the vessel and the cylindrical volume obtained by multiplying the area of the mid-ship section by the length of the vessel. After displacement and length the cylindrical coefficient is the most important variable affecting resistance. The area of and hence the power absorbed by the wetted surface depend almost entirely upon the displacement and the length, and we are enabled to draw one curve of frictional effective horse-power, it being the same in the first approximation for any cylindrical coefficient. From accumulated data of systematic experiments we are able to further calculate curves of residuary horse-power for the various coefficients, which, added to the curve of frictional horse-power, give the curves of Fig. 3. In developing for an actual vessel of the size and length the most desirable lines we could improve somewhat upon the results of Fig. 3, but not very much. It is seen that up to any speed which might be regarded at present within the realm of possibility, say, up to 30 knots, the friction is the main factor. This is generally true; that is to say, there are very few vessels where the residuary resistance is greater than the frictional resistance. A few high-speed navy cruisers, torpedo boats, and torpedo-boat destroyers, and fast passenger vessels for short runs may have residuary resistance greater than the frictional resistance. Even for fast vessels, as a rule, the residuary resistance is not more than a third of the total, or one-half the frictional resistance. Excessive residuary resistance means that the vessel is too short for her speed, and it can be reduced by increasing length without much increase in frictional resistance.

It will be observed in Fig. 3 that at practicable speeds there is much more difference in total effective horse-power between cylindrical coefficients of 0.60 and 0.65 than between 0.55 and 0.60. At 0.55 we are close to the minimum. It will also be observed that at the top speed the curve for the 0.55 coefficient is beginning to rise beyond that for 0.60 coefficient. This is typical. Numerous experiments have shown that for speeds which are moderate in proportion to the length of the vessel the cylindrical coefficient should be low; while for speeds which are high in proportion to the length, say, speeds in knots twice or more the square root of the length in feet, the cylindrical coefficient may be given with advantage surprisingly large values, as high as 0.65 or 0.66. For excessive speeds, at which the vessel begins to rise bodily from the water, the cylindrical coefficient may be made even greater, or, in other words, the ends may be made very full.

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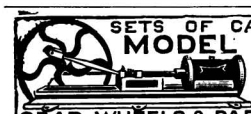

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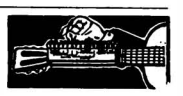

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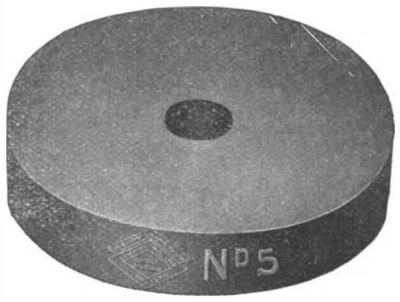

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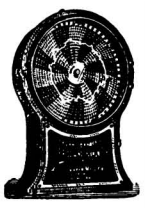

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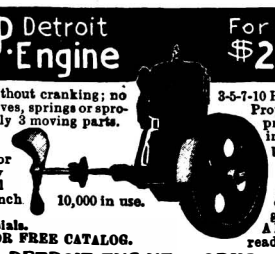

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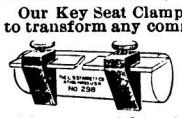

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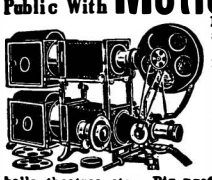

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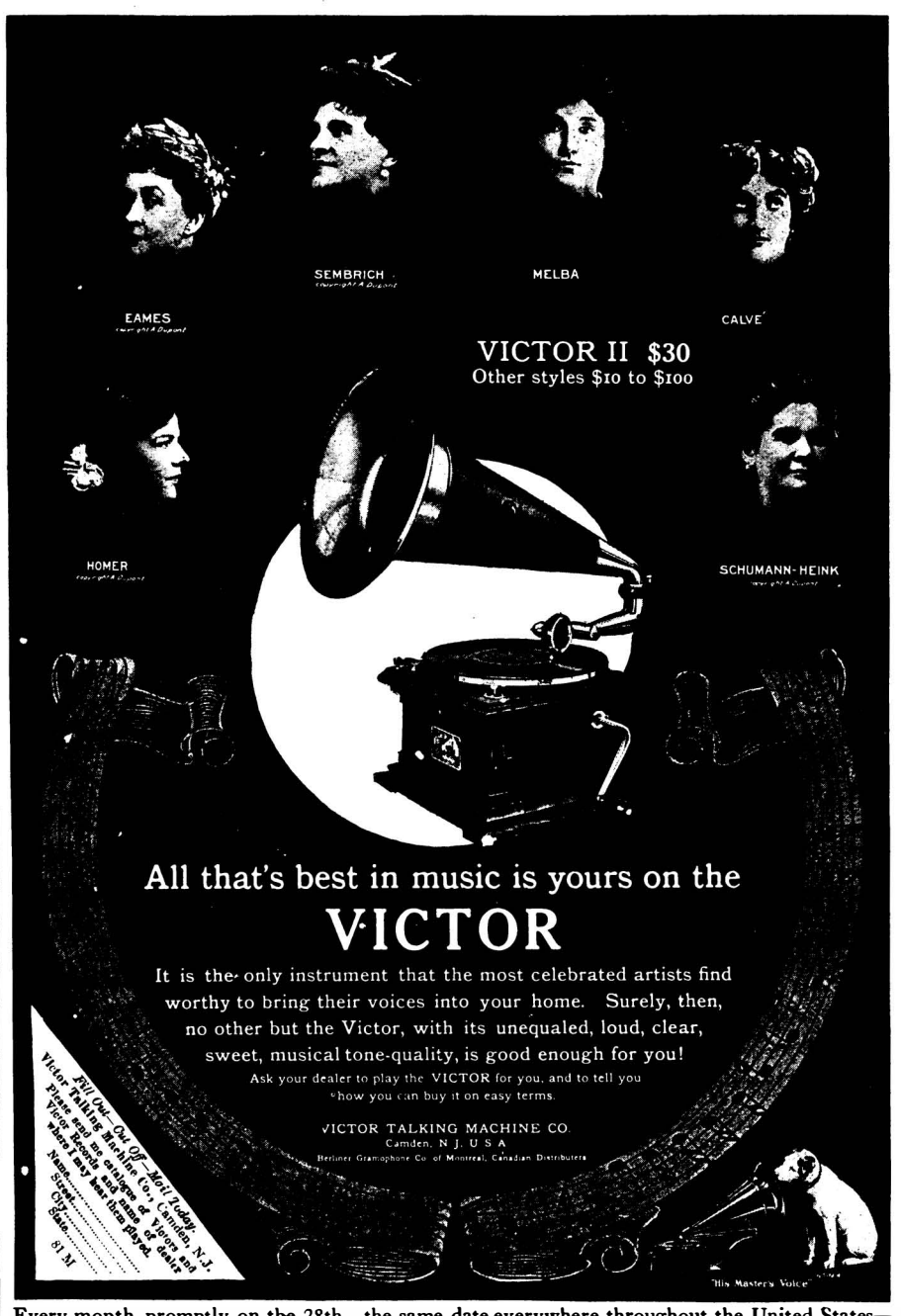
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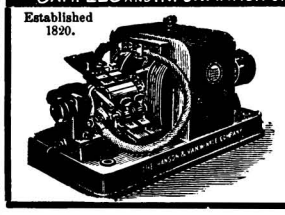

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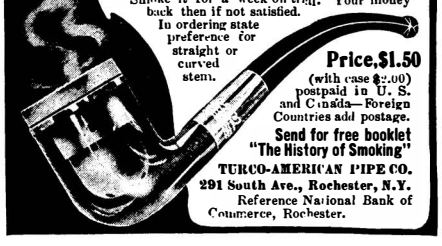

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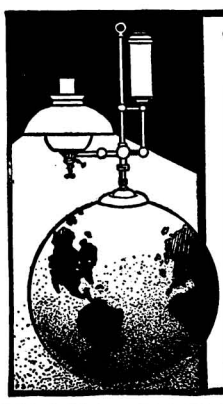

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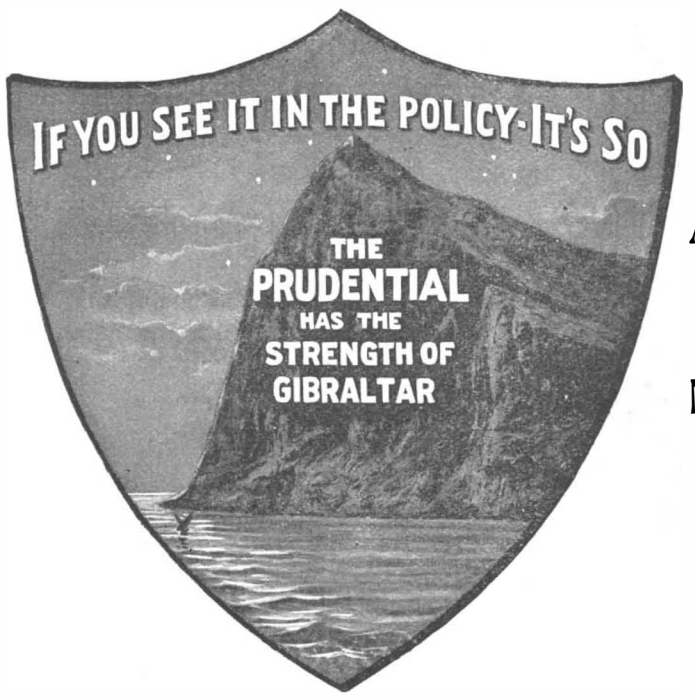

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